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**Mystic Avenue/Route 28/I-93
Interchange Improvement Study
Somerville, Massachusetts**



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Planning Staff for the
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Mystic Avenue/Route 28/I-93 Interchange Improvement Study Somerville, Massachusetts

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Introduction

This report provides the supporting documentation for work completed by CTPS for the "Mystic Avenue/Route 28 and I-93 Interchange Feasibility Study" in Somerville. The feasibility study was prepared by Vollmer Associates for the MHD to develop design alternatives for improving the I-93 interchange at Route 28 and Mystic Avenue. As part of this study CTPS was requested by the MHD to provide build year (2000) and design year (2020) traffic forecasts for alternatives analysis, and to determine the impact of the preferred alternative on the existing highway system. The project area is shown in Figure 1.

Background

The purpose of this project is to develop long-range improvements that will alleviate the recurring traffic congestion and resulting safety problems at the I-93 and Route 28/Mystic Avenue interchange. This interchange is located approximately two miles upstream from the congested Central Artery and provides the last available diversion point for traffic approaching the back of the Central Artery queue. Motorists destined for Boston who choose to avoid the Artery can either travel southbound via Mystic Avenue to Rutherford Avenue or take Route 28 to Storrow Drive.

The problems associated with heavy commuter traffic during the morning rush hour are compounded by the lack of complete access to and from the I-93/Route 28 interchange. The layout of the interchange is shown in Figure 2. Access to I-93 is provided at different points along Mystic Avenue, which serves as a frontage road for a limited distance. For example, motorists on Route 28 destined for I-93 northbound must travel on Mystic Avenue to a northbound slip ramp located approximately 3,400 feet north of Route 28, or travel south on Mystic Avenue and reverse direction at Lombardi Street for a distance of approximately 4,000 feet before entering a slip ramp located in the southeast quadrant of the interchange. Thus, the lack of direct access between Route 28 and I-93 creates additional traffic and safety problems on the local street system, particularly Mystic Avenue.

Model Development

A traffic simulation model was used to develop design hour forecasts for the I-93/Route 28 study area. This model was specifically developed for this project in order to capture the effects of possible diversions that could result from each alternative, and to estimate the impact of the preferred design on the surrounding highway system. In addition, to be eligible for Federal-aid the impact of the project on adjacent interchanges would have to be estimated. This would include the I-93 southbound off-ramps to Route 16 and Mystic Avenue north of the project and the Sullivan Square interchange south of the project. A specific concern was the impact that the Central Artery/Third Harbor Tunnel project (CA/T) would have on future traffic patterns in the study area. To capture the impact of this project and correctly estimate design hour forecasts for the preferred alternative, the model area was extended to include the Charles River crossings, (I-93 Central Artery, North Washington Street Bridge, and Route 28/Charles River Dam) including Storrow Drive. Traffic forecasts for the CA/T and river crossings were taken directly from the

Figure 1
Project Area Map

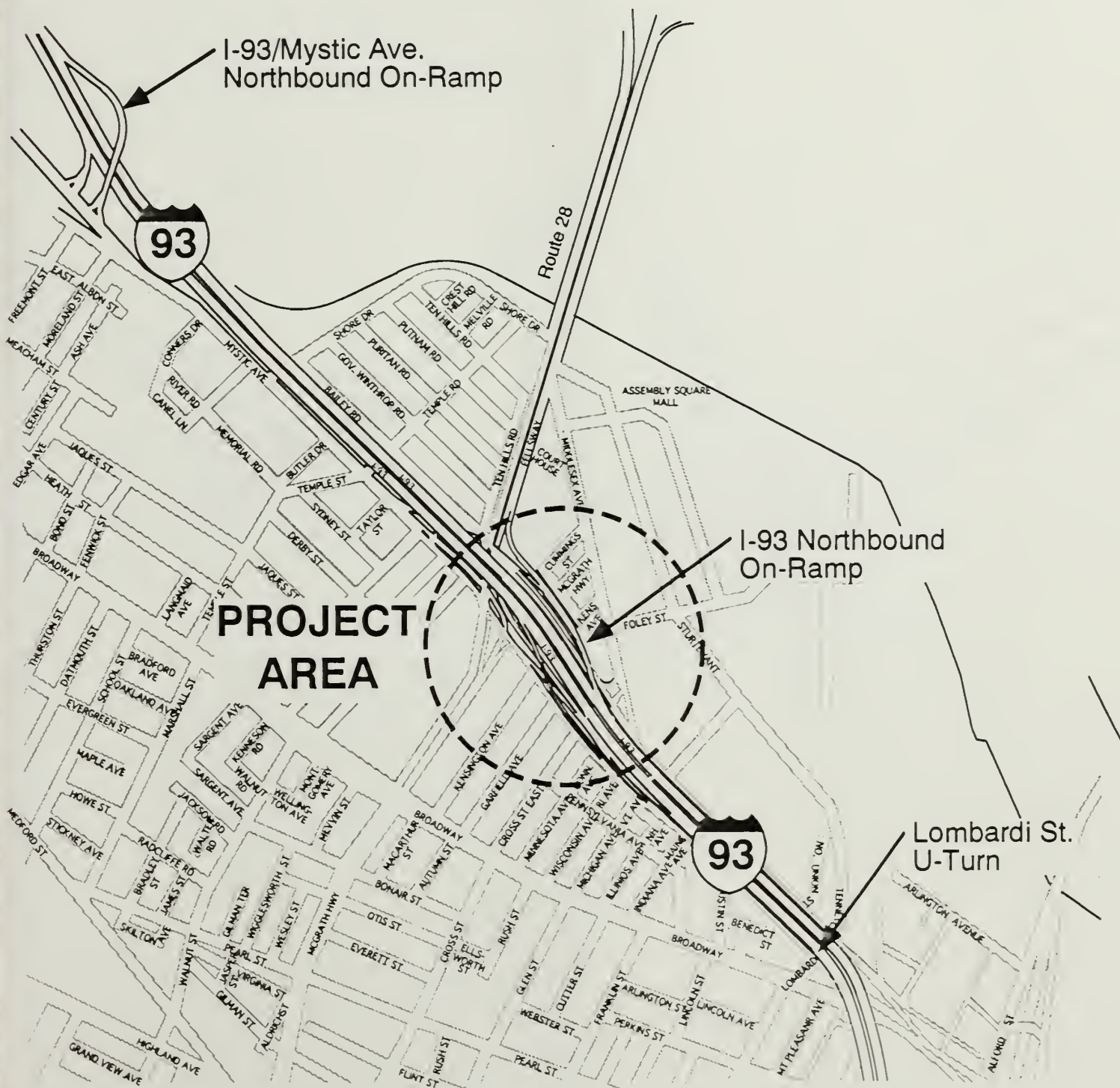
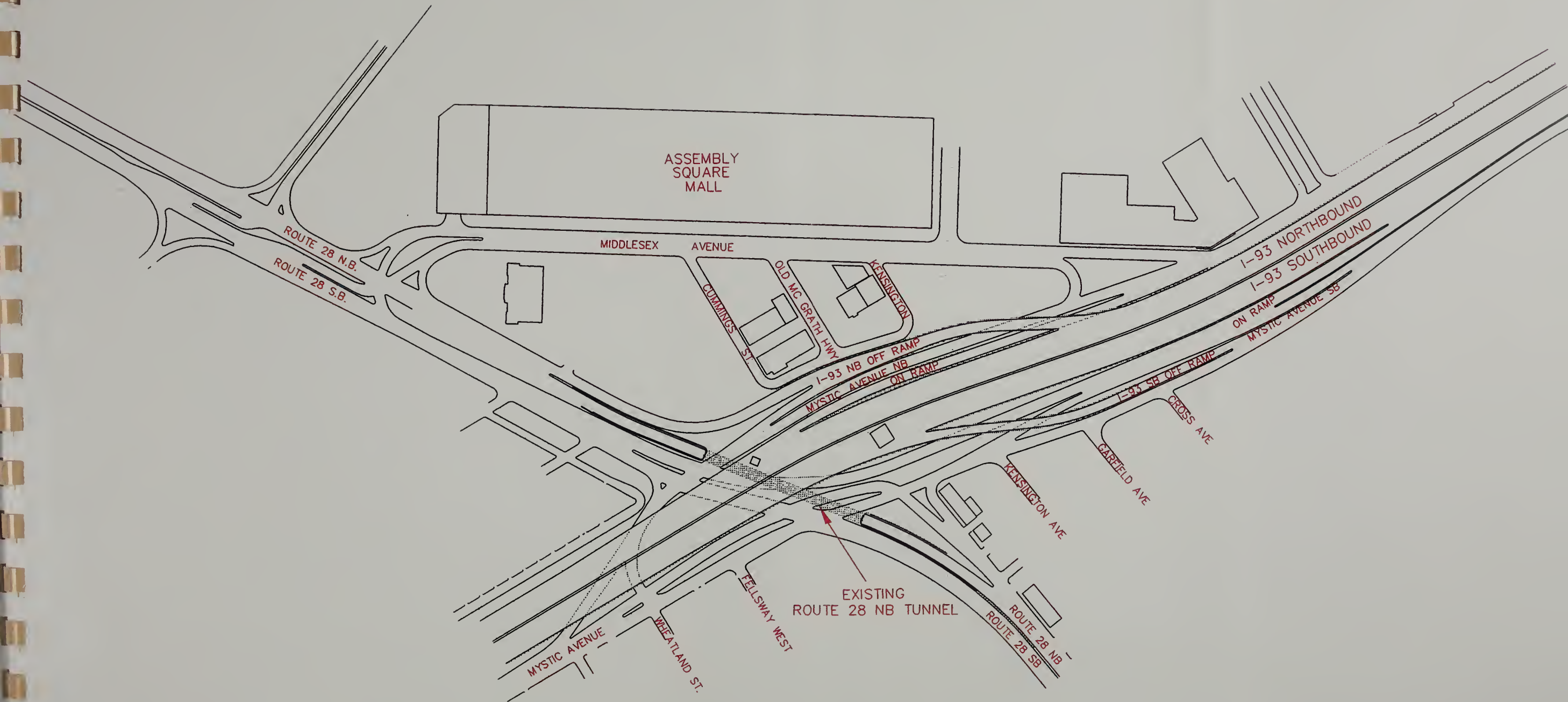


Figure 2
Mystic Avenue/Route 28/I-93
Interchange Schematic



larger Central Area model developed by CTPS for the CA/T project. Thus, the study area included all of the major diversionary routes that could be affected by any changes in the project area, including the future construction of the CA/T project.

The peak hour model was developed for the AM and PM peak hours using the CTPS micro-computer travel demand software, known as The Highway Emulator (THE). This model was calibrated using 1990 peak hour traffic count data for the study area. A link-node map detailing the study area model network is shown in Figure 3. The model consists of 649 highway links and 83 traffic analysis zones (TAZ). A TAZ represents an aggregation of households and employment for a designated area. Base year household and employment data was taken from the 1990 Census. The number of trips generated by each TAZ is dependent on the number of households and type of employment in each TAZ. The resulting trips generated is translated by the model into peak hour traffic volumes which are calibrated to actual traffic count data taken at selected locations. Calibration of the model resulted in an average Root Mean Square Error (RMSE) of 8.1% for the AM model and 8.5% for the PM model.

Travel demand forecasts for year 2000 and 2020 were estimated from regional forecasts of population and employment made by the Metropolitan Area Planning Council (MAPC). These forecasts were used as the principal determinant of traffic growth since they represent land use changes over a larger area than the immediate study area. Refer to Table 1. However, future site specific land developments in the project area were also integrated with these forecasts. In addition, consistency with the Central Artery/Third Harbor Tunnel project traffic forecasts for I-93, Storrow Drive, Route 16 and Route 1 were maintained.

Table 1
MAPC Population and Employment Forecasts

City/Town	Population			Employment		
	1990	2000	2020	1990	2000	2020
Boston	578,712	599,458	597,523	543,400	576,900	580,600
Cambridge	93,768	93,972	90,775	104,400	108,600	115,200
Chelsea	28,222	30,444	31,404	9,800	9,300	8,000
Everett	35,236	33,143	32,391	12,200	12,900	12,400
Medford	56,950	56,615	54,208	19,700	22,000	23,900
Somerville	75,061	74,437	71,162	20,400	22,000	23,200

The following developments were explicitly included in the year 2000 and 2020 forecasts:

The proposed Sullivan Square MBTA parking garage; (583 new parking spaces) estimated 406 new peak hour trips inbound and 30 outbound during the AM peak hour; and 292 outbound trips and 25 inbound trips during the PM peak hour.

Wellington Business Center office expansion; (250 ksf) estimated 245 new peak hour trips inbound and 50 outbound during the AM peak hour; and 360 outbound trips and 48 inbound during the PM peak hour.

Figure 3
Link/Node Map
Highway Simulation Model



Mystic Center office expansion and new hotel; (224 ksf and 285 room hotel) estimated 471 peak hour trips inbound and 98 outbound during the AM peak hour; and 456 outbound and 146 inbound trips during the PM peak hour.

Assembly Square Mall retail expansion and proposed new office development. The City of Somerville plans for developing this site include proposals for low, medium and high density development. The low density development would consist of 1.5 million square feet of predominantly office space and the high density proposal would include up to 3.5 million square feet of new development. However, these plans are not consistent with low MAPC employment forecasts in the area and do not consider the limitations of market competition for development. Therefore, development forecasts for this site were scaled down to reflect regional growth trends. The forecast development for this site consists of 400 ksf of office development, the 180 ksf Home Depot development and 100 ksf retail expansion of the existing mall. This scenario would result in roughly 750 new AM peak hour trips to the site and 130 AM trips from the site during the AM peak hour; and 964 outbound trips and 390 inbound during the PM peak hour.

Alternatives Analysis

After an initial screening of design concepts which would alleviate existing congestion and improve safety in the project area, four conceptual design alternatives were selected by the MHD for further analysis by Vollmer Associates. As part of this analysis, leading to the recommendation of a preferred alternative and subsequent feasibility report, traffic forecasts were prepared by CTPS for each of the conceptual design alternatives. Each alternative was coded into the base model and peak hour traffic assignments were produced for the 1990 base conditions, build year 2000 and design year 2020. The following is a brief description of each alternative:

Alternative 1

Alternative 1 would involve the construction of a new Route 28 northbound underpass and reconstruction of the existing northbound underpass for southbound travel. The remaining at-grade turning movements would be made through a one-way, rotary type operation consisting of four traffic signals. Refer to Figure 4.

Alternative 2

Alternative 2 would relocate the existing I-93 northbound off-ramp and northbound Route 28 traffic to Middlesex Avenue. Route 28 southbound would use the existing northbound tunnel underneath I-93. Refer to Figure 5.

Alternative 3

Alternative 3 would involve constructing tunnels for the northbound and southbound left turn movements from Route 28 to Mystic Avenue. Through traffic on Route 28 and Mystic Avenue would be handled at-grade. Refer to Figure 6.

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Figure 5
Alternative 2

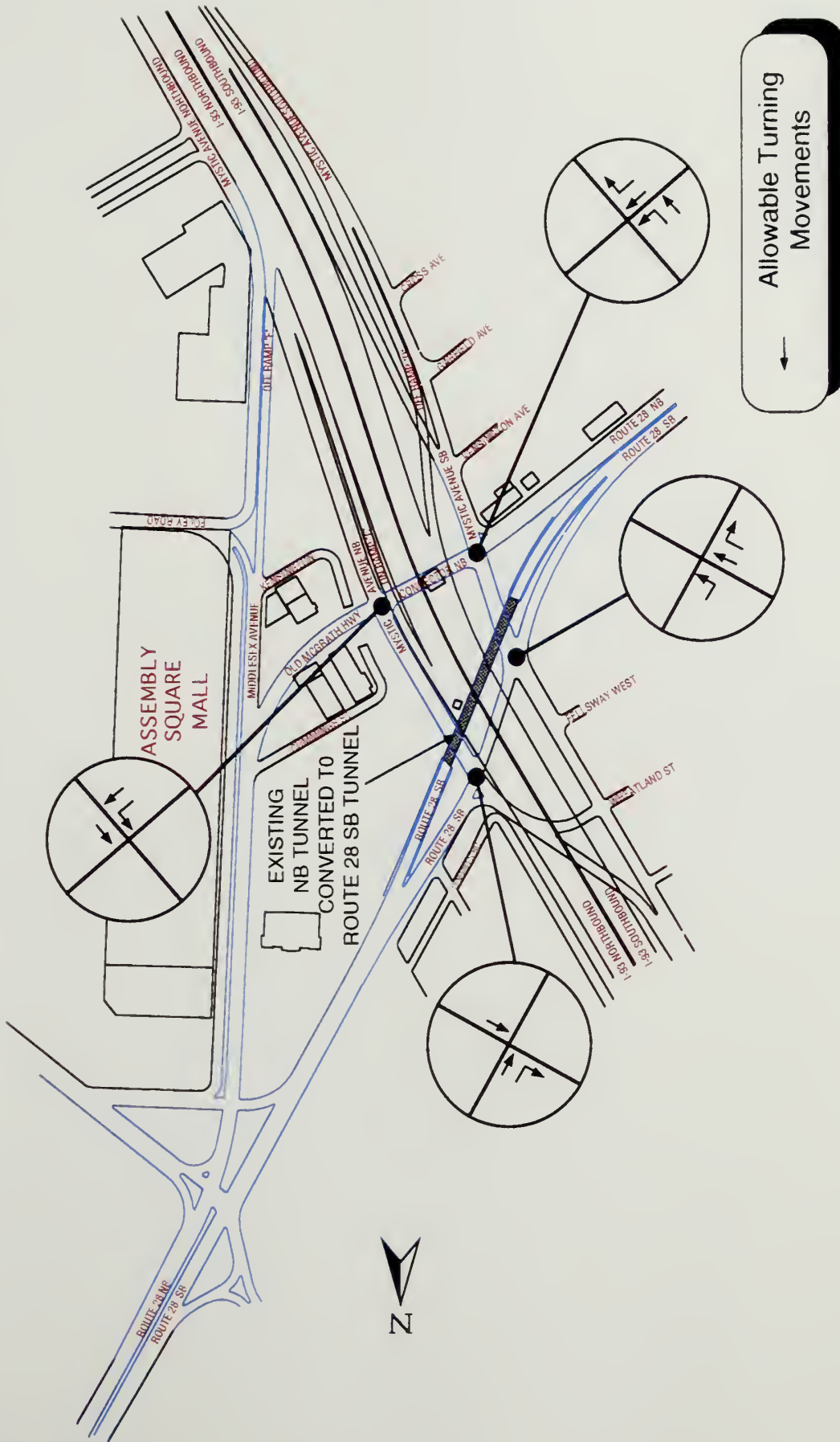
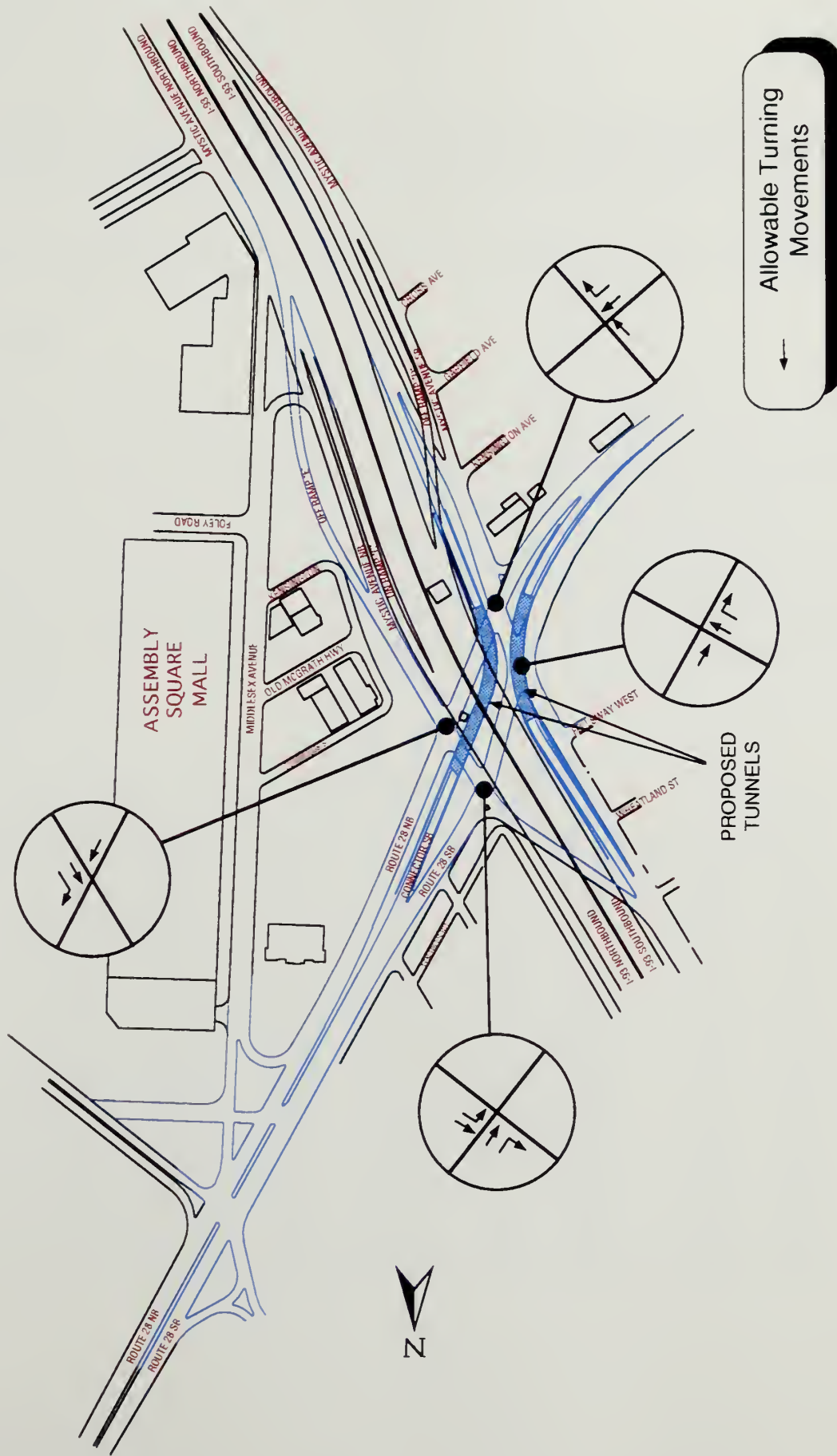


Figure 6
Alternative 3



Alternative 4

Alternative 4 would replace the northbound left turn to Mystic Avenue with channelization of all northbound Route 28 traffic through the existing tunnel to a new Middlesex Avenue cloverleaf ramp with direct access to I-93 northbound. Refer to Figure 7.

Link volume maps of base year and forecast year traffic assignments for Alternatives 1 through 4 are provided in Appendices.

Traffic Forecasts

Traffic volume forecasts for the study area in the AM peak hour resulted in an average increase of 20% between 1990 and 2000, and 8.5% between 2000 and 2020. In general, there were higher increases for through trips and lower increases for trips with origins and destinations inside the study area. The roads with the highest traffic increase in the project area are Route 28 southbound, I-93 southbound and the I-93 southbound exit ramp to Sullivan Square and Rutherford Avenue. For illustration purposes, screen line counts were selected from the model at the Charles River Dam, Austin Street, I-93 north and south, Rutherford Avenue, Route 16, Route 16 off-ramp from I-93 southbound, and the on/off ramps for Mystic Avenue. Refer to Figure 8. Traffic growth at these screen line locations are summarized in Table 2, AM peak hour, and Table 3, PM peak hour.

Table 2
Projected Growth for AM Model

Location #	Volumes		Difference	Percent Increase	Volumes		Difference	Percent Increase
	1990	2000			2000	2020		
4(NB)	3236	3712	476	14.71%	3712	3978	266	7.17%
1(SB)	1077	1221	144	13.37%	1221	1376	155	12.69%
2(EB)	1028	1202	174	16.93%	1202	1333	131	10.90%
2(WB)	1384	1567	183	13.22%	1567	1702	135	8.62%
3(NB)	3071	3740	669	21.78%	3740	4103	363	9.71%
3(SB)	3105	4215	1110	35.75%	4215	4687	472	11.20%
4(NB)	1100	1397	297	27.00%	1397	1528	131	9.38%
4(SB)	3691	4252	561	15.20%	4252	4569	317	7.46%
5(EB)	2135	2911	776	36.35%	2911	3191	280	9.62%
5(WB)	935	1276	341	36.47%	1276	1365	89	6.97%
6(NB)	3615	4602	987	27.30%	4602	5185	583	12.67%
6(SB)	8022	10352	2330	29.05%	10352	11338	986	9.52%
7	1610	2329	719	44.66%	2329	2570	241	10.35%
8	496	690	194	39.11%	690	806	116	16.81%
9	885	1187	302	34.12%	1187	1273	86	7.25%



Figure 7
Alternative 4

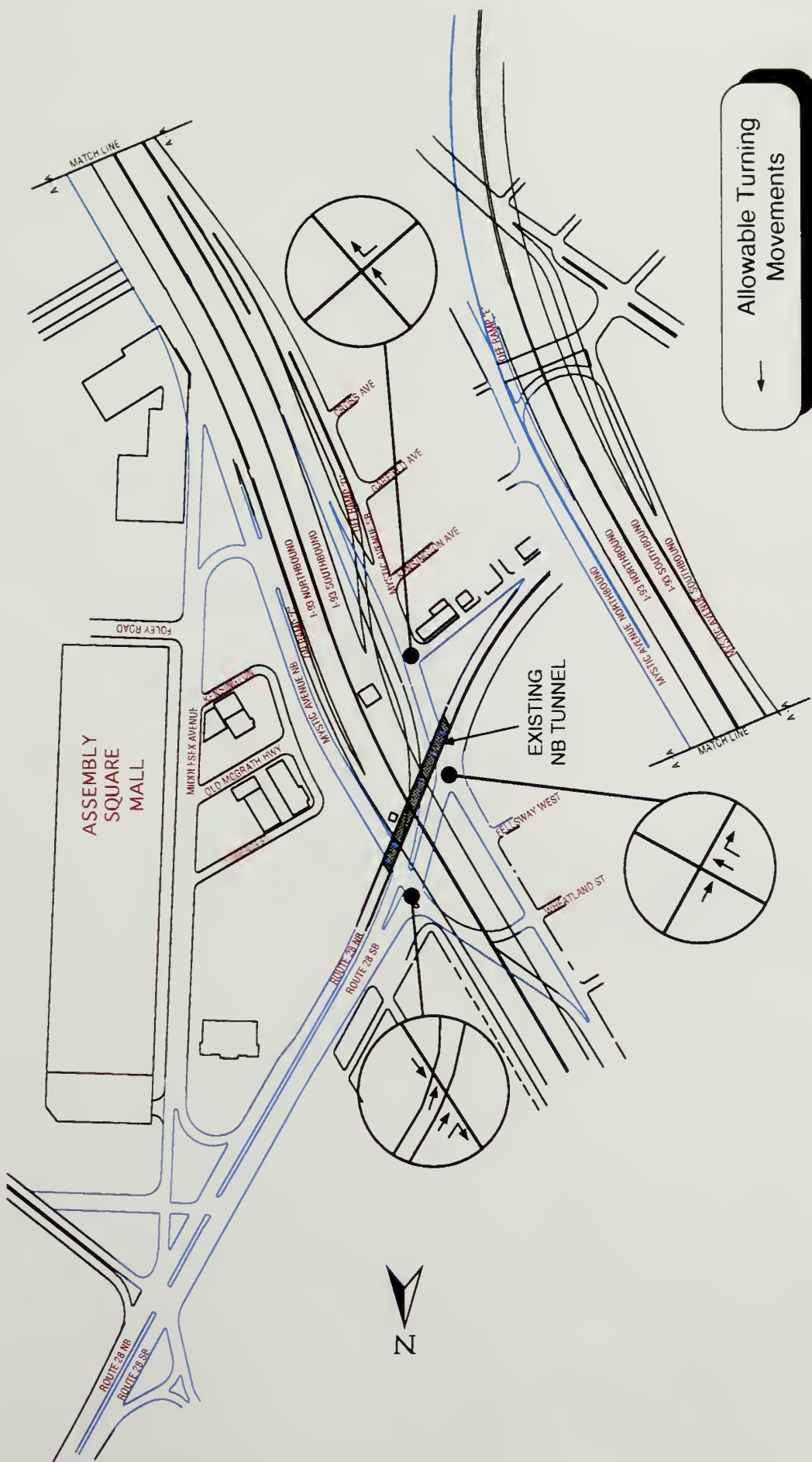


Figure 8
Screen Line Locations

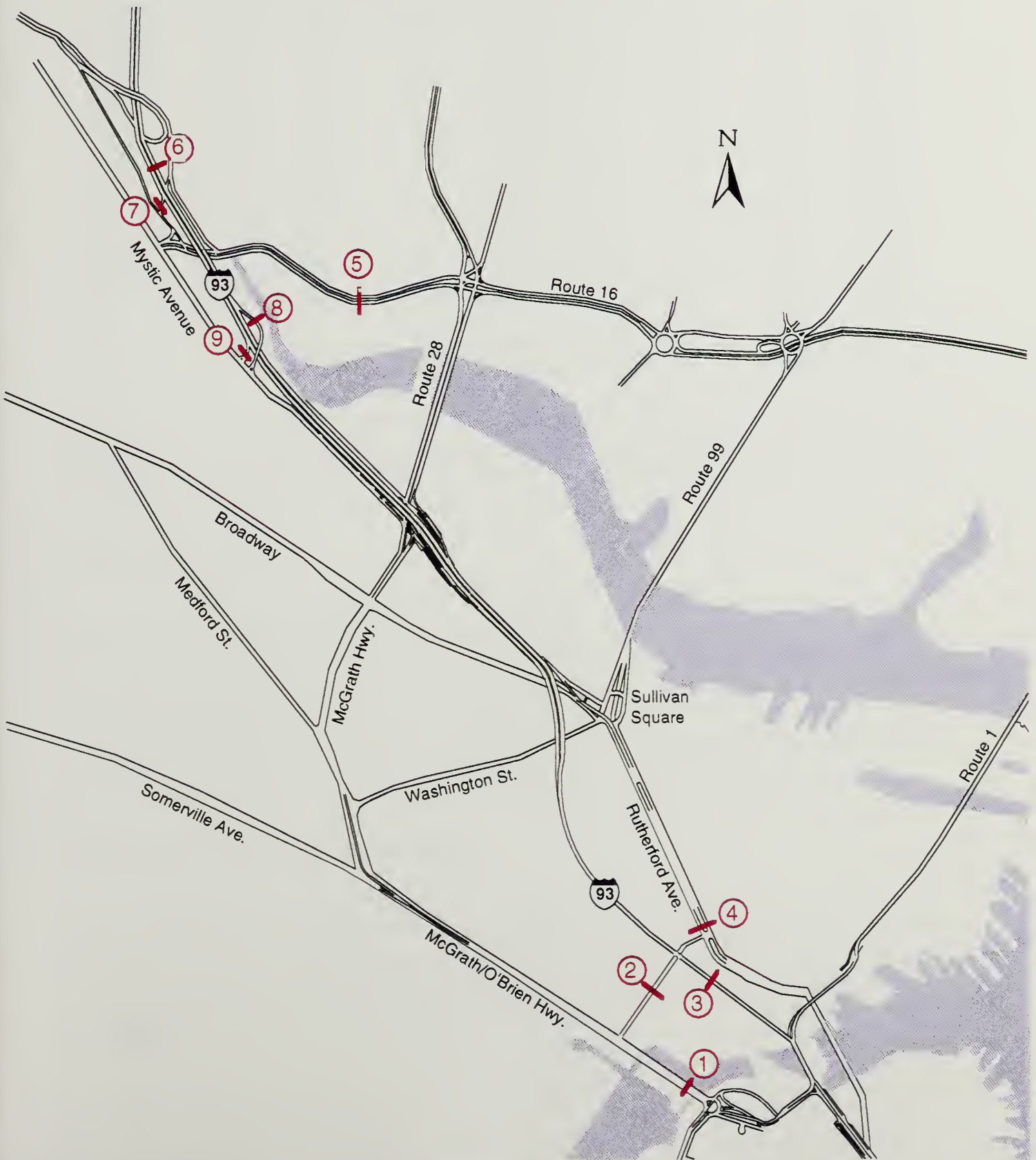


Table 3
Projected Growth for PM Model

Location #	Volumes		Difference	Percent Increase	Volumes		Difference	Percent Increase
	1990	2000			2000	2020		
1(NB)	1358	1796	438	32.25%	1796	2209	413	23.00%
1(SB)	892	1022	130	14.57%	1022	1225	203	19.86%
2(EB)	1640	1782	142	8.66%	1782	1976	194	10.89%
2(WB)	1120	1515	395	35.27%	1515	1782	267	17.62%
3(NB)	2844	3348	504	17.72%	3348	3409	61	1.82%
3(SB)	3845	4509	664	17.27%	4509	4935	426	9.45%
4(NB)	2301	2509	208	9.04%	2509	2660	151	6.02%
1(SB)	1569	2077	508	32.38%	2077	2448	371	17.86%
5(EB)	1907	2221	314	16.47%	2221	2416	195	8.78%
5(WB)	1681	2006	325	19.33%	2006	2211	205	10.22%
6(NB)	7602	9246	1644	21.63%	9246	10191	945	10.22%
6(SB)	5352	6565	1213	22.66%	6565	7201	636	9.69%
7	838	1081	243	29.00%	1081	1180	99	9.16%
8	1858	2372	514	27.66%	2372	2722	350	14.76%
9	761	975	214	28.12%	975	1021	46	4.72%

As the tables indicate, most of the traffic growth occurs between the years 1990 and 2000. This growth rate is the result of two factors: the specific land developments previously mentioned are assumed to be constructed by the year 2000, and the lower rate of regional employment growth forecast between 2000 and 2020.

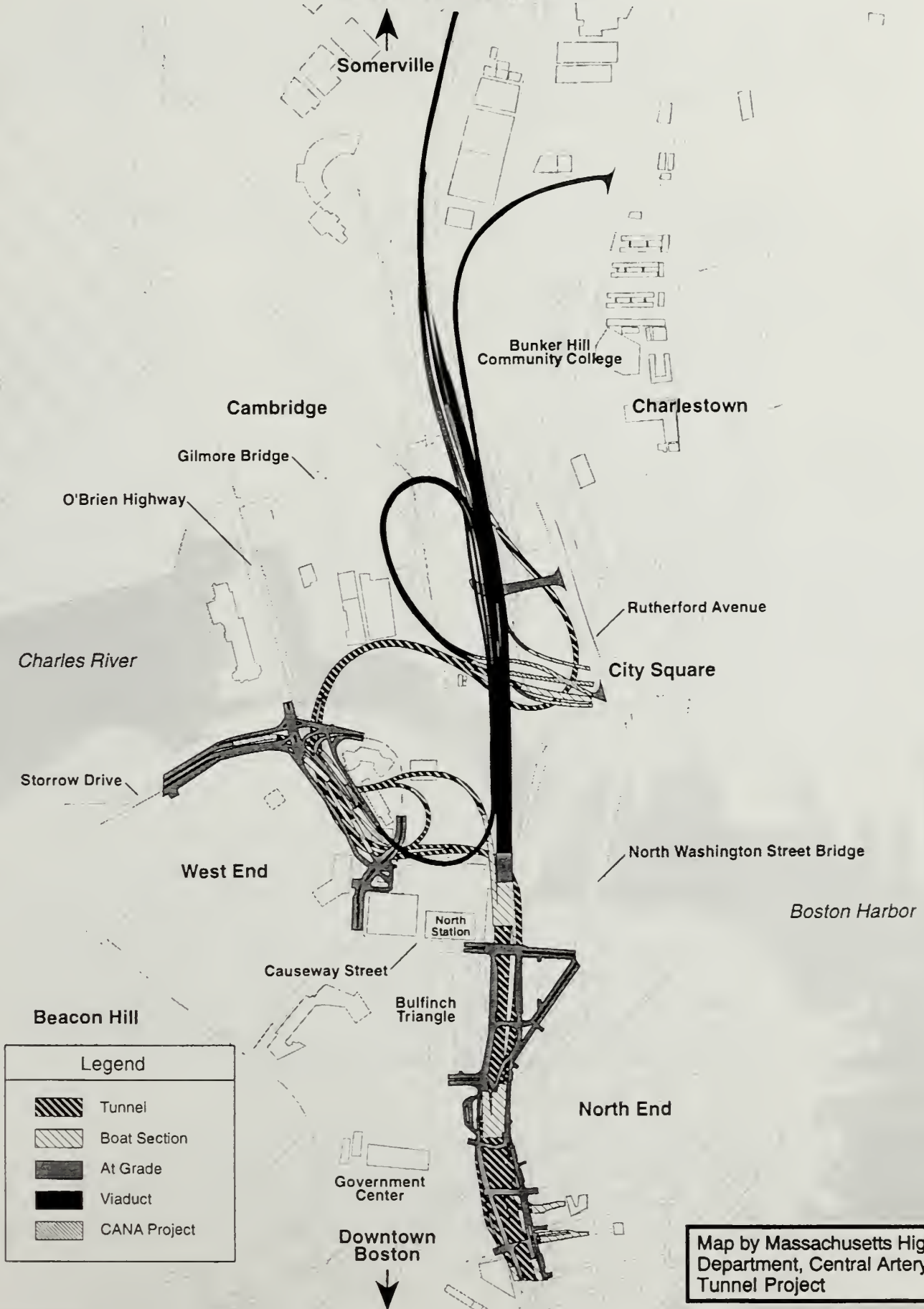
Central Artery Project

For the purposes of this study it was assumed that the Central Artery/Third Harbor Tunnel (CA/T) project will be completed by the year 2000. Refer to Figure 9. This project was included in the I-93/Route 28 interchange study because it will impact the I-93/Route 28 interchange project area and consequently the selection of any design improvements. In addition, the traffic impact of the preferred design on the interchanges upstream and downstream of the project site would need to be determined as part of the feasibility report. The following section describes the traffic impacts of the new Central Artery Charles River crossing on the project area. A later section describes the traffic impact of the preferred design on I-93 in the study area.

Traffic Impact of CA/T on the Project Area

I-93 crosses over the Charles River on a bridge that has a cross-section of ten lanes, four lanes in each direction. One of the southbound travel lanes from Sullivan Square to just north of the Charles River will be an HOV lane. Access to I-93 northbound and Route 1 northbound will be provided by a three-lane tunnel that loops under the site of the Boston Thermal Corporation's Minot Station steam generating plant, beneath the relocated MBTA Green Line and under the Charles River.

Figure 9
Alternative 8.1D Mod 5
Charles River Crossing DSEIS/R



To determine the impact of the CA/T project on the I-93/Route 28 Interchange study area, the model was tested under scenarios with and without the CA/T project for existing 1990, and future year 2000 and 2020 peak hour time periods. For illustration purposes, a comparison of year 2000 AM traffic forecasts with and without the proposed CA/T design is provided in Table 4.

Table 4
Year 2000 and 2020 AM Volume Comparison with and without the CA/T

Location	Year 2000				Year 2020			
	Without CA/T	With CA/T	Difference	% Change	Without CA/T	With CA/T	Difference	% Change
Rt. 28 NB North of Area	1209	1191	-18	-1.49%	1368	1383	15	1.10%
Rt. 28 SB North of Area	3985	3949	-36	-0.90%	4203	4117	-86	-2.05%
Rt. 28 NB South of Area	1063	1220	157	14.77%	1145	1465	320	27.95%
Rt. 28 SB South of Area	3556	3226	-330	-9.28%	3762	3641	-121	-3.22%
Mystic Ave NB North of Area	794	819	25	3.15%	832	873	41	4.93%
Mystic Ave SB North of Area	1452	1392	-60	-4.13%	1516	1708	192	12.66%
Mystic Ave NB from Sullivan Sq	1577	1098	-479	-30.37%	1774	1259	-515	-29.03%
Mystic Ave SB to Sullivan Sq	4103	3178	-925	-22.54%	4280	3432	-848	-19.81%
I-93 NB North of Area	3912	3955	43	1.10%	4379	4463	84	1.92%
I-93 SB North of Area	6836	7010	174	2.55%	7495	7549	54	0.72%
I-93 NB South of Area	4215	4854	639	15.16%	4686	5403	717	15.30%
I-93 SB South of Area	3740	5321	1581	42.27%	4103	5816	1713	41.75%
Mystic Ave NB On-Ramp	690	647	-43	-6.23%	806	722	-84	-10.42%
Mystic Ave SB Off-Ramp	1187	1043	-144	-12.13%	1273	1258	-15	-1.18%
Sullivan Sq NB On-Ramp	682	448	-234	-34.31%	720	525	-195	-27.08%
Sullivan Sq NB Off-Ramp	985	1347	362	36.75%	1027	1464	437	42.55%
Sullivan Sq SB On-Ramp	477	1039	562	117.80%	496	1206	710	143.00%
Sullivan Sq SB Off-Ramp	3573	2728	-845	-23.65%	3888	2939	-949	-24.41%

As can be seen from this table, the CA/T project increases the main line volumes on I-93 by 15.16% northbound and 42.27% southbound in the year 2000. There is a corresponding decrease in traffic on the arterial street system. For example, the Sullivan Square off-ramps from I-93 southbound at Mystic Avenue and Sullivan Square decreases by 12.13 % and 23.65% respectively. This indicates that during the AM peak hour motorists traveling on I-93 southbound are not diverting to the parallel street system to avoid the bottleneck on I-93 caused by the existing merge of Route 1 at the Central Artery. Furthermore, motorists are attracted to I-93 due to the increase in Artery capacity. This is illustrated by the 26% increase on the I-93 southbound on-ramp from Route 28 southbound and the 117% increase at the Sullivan Square on-ramp to I-93 southbound.

There is a similar pattern northbound where motorists previously using the surface streets are now using I-93 northbound for a higher percentage of their trip. For example, the on-ramps to I-93 northbound at Sullivan Square and Mystic Avenue show a decrease in volumes, with the Sullivan Square on-ramp decreasing by 34.31% and the Mystic Avenue on-ramp decreasing by

6.23%. Link volume maps of existing conditions with and without the CA/T project are provided in Appendix.

Preferred Alternative

The evaluation and screening of Alternatives 1 through 4 was completed by Vollmer Associates after reviewing the traffic forecasts completed by CTPS. This work is fully documented by Vollmer in their Feasibility Report, completed in July of 1993, and will not be reviewed in this report.

The resulting preferred alternative is a hybrid of alternatives 1 and 4. It will include a new underpass grade separating Route 28 northbound; the existing underpass will be used for Route 28 southbound. In addition, the preferred alternative will include the construction of a new connector road between Mystic Avenue and Middlesex Avenue, and the reconstruction of the I-93 northbound off-ramp to permit the connector road access to Assembly Square Mall. The Route 28 surface street system will operate in a one-way rotary style operation controlled by four traffic signals; one signal more than the currently exists. Refer to Figure 10.

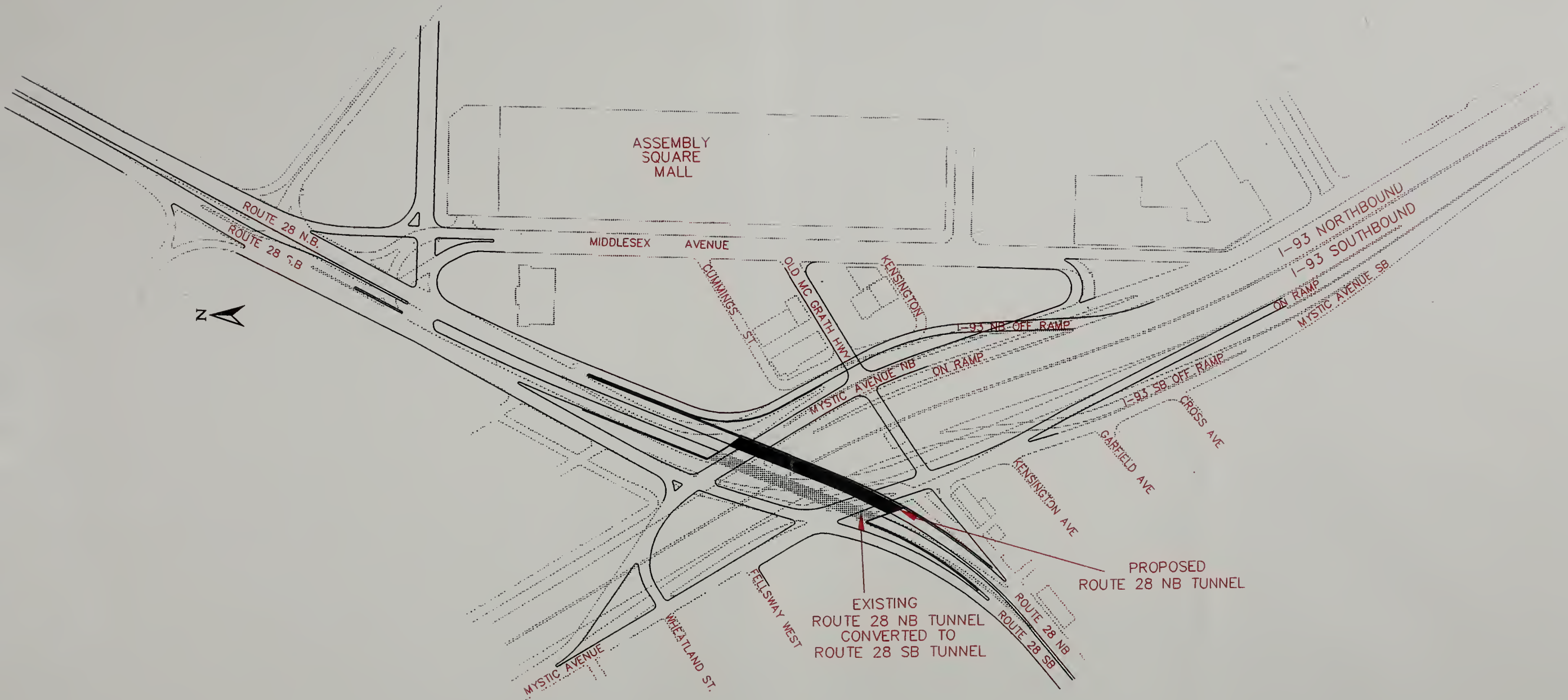
The most significant improvement in traffic flow attributed to the preferred alternative is the grade separation of Route 28 southbound. This improvement eliminates the heavy Route 28 southbound traffic from signal operation at Mystic Avenue, simplifies signal phasing, and permits a one-way traffic pattern on the surface street system underneath the elevated I-93. Additional benefits include the elimination of short weaving and merging conflicts, improved sight distance and channelization, and improved level of service (LOS).

Although Vollmer Associates performed LOS analyses for each alternative as part of their work, these analyses were done under the assumption that each intersection operated as an isolated intersection with common background cycle lengths and phase splits. While this assumption is adequate for the comparison of alternatives, CTPS was asked to provide a more detailed analysis of the preferred alternatives a system of coordinated signals.

The preferred alternative consists of four signalized intersections arranged in a grid pattern. The distance between three of the intersections is approximately 320 feet; and the fourth intersection is 520 feet from the first intersection. Due to the close proximity of these intersections, the signal timing plans will have to operate as a coordinated system in order to manage queuing. This requires the same background cycle length for each intersection, which can decrease the flexibility of the individual intersection to service traffic demand. Thus, the analysis of coordinated systems typically results in lower operating levels of service.

In addition, there are three other intersections that should be coordinated with the four previously mentioned: These are: Route 28/Assembly Square Mall entrance, located approximately 890 feet north; Mystic Avenue at Wheatland Street, located 450 feet west; Route 28 and Broadway, located approximately 1540 feet south; and Middlesex Avenue/ Assembly Square connector (created as part of the preferred alternative), located 400 feet northeast. However, in order to simplify the signal timing plan which will be developed for analysis, only the

Figure 10
Preferred Alternative Layout



four principal intersections first mentioned will be tested.

Analysis of Preferred Alternative

The analysis of the preferred alternative as a coordinated signal system was done using the Transyt 7F signal timing optimization program and the Traf-Netsim traffic simulation program. The Transyt 7F program was used to optimize the signal timing plans as an inter-connected system for the year 2020 AM peak hour. The recommended timing plans and offsets from Transyt were then input into the Traf-Netsim program for simulation. The Traf-Netsim program simulates the actual movement of each vehicle through the network on a second by second basis. This technique provides a more accurate estimate of queuing and delays than the Transyt 7F program. In addition, Traf-Netsim provides graphic animation of the simulated traffic flow on the computer screen as a diagnostic tool to determine problem locations.

For illustration purposes, Table 5 provides a comparison of the average LOS for the following scenarios during the AM peak hour: existing 1990 base year conditions, year 2020 no-build conditions, and year 2020 build conditions. The first three columns of Table 5 indicate the results of the intersection analysis using CINCH, the micro-computer program based on methods outlined in the 1985 Highway Capacity Manual. The last two columns show the results of Transyt 7F and Traf-Netsim analyses as a system of coordinated intersections. The first column provides LOS on existing conditions for background purposes only. It should be noted that extensive analysis of the preferred alternative was not the focus of the CTPS work effort and was done in order to point out obvious problems which will have to be considered as the design process continues. Therefore, the PM time period was not analyzed as part of this report.

Table 5
LOS Comparison for the AM Peak Hour

Intersection	Isolated			Coordinated	
	1990 Existing	2020 No Build	2020 Build	2020 Transyt	2020 Netsim
Mystic Av. NB/Rt.28 inbound	B	B	C	C	D
Mystic Av. SB/Rt.28 inbound	C	F	B	C	E
Mystic Av. SB/Rt. 28 outbound	C	C	C	E	D
Mystic AV. SB/Assembly Mall Connector	n/a	n/a	B	E	E
Rt.28/Broadway	F	F	F	n/a	F

As can be seen from this table, the LOS analysis for year 2020 build is better when analyzed as an isolated intersection (Refer to Figure 11) than when analyzed as an inter-connected signal system using the Transyt 7F and Traf-Netsim programs. However, the results of this analysis are based on only one time period of data and may not include the best phasing and timing for this system. In reality signal timing plans would have to be adjusted in the field over time due to the high variability of traffic volumes. In addition, geometric changes at one intersection can improve the LOS at all of the intersections. The following conclusions could be made from the Traf-Netsim analysis of the AM peak hour and should be considered when developing the preferred alternative beyond the 25% design stage.

Figure 11



The results of the Traf-Netsim analysis of the preferred alternative show that the four signals operating as a one way rotary system can function acceptably during the AM peak hour with 2020 forecast volumes, however, several obvious improvements can be made.

First, the signal timing used is a 120 second cycle with fixed offsets designed to manage the internal queuing and prevent spill back. Thus, traffic is not allowed to enter the system until the internal traffic clears the intersection. Due to the high variability of traffic volumes a demand responsive system which can change offsets according to changing demand would improve the circular flow through the rotary. This is illustrated in Figure 12 where several links appear almost empty while traffic is queued upstream.

Second, there are some intersection approaches that are over-saturated due to lack of capacity. From Figure 13 it can be seen that queues are excessive for the southbound Mystic Avenue through movement to Route 28 southbound, the right turn movement from the Assembly Mall connector to Mystic Avenue northbound, and the Route 28 southbound approach to Broadway. The vehicle delay for each approach exceeds LOS "F". Since the Assembly Mall connector will be constructed new, it is recommended that dual right turn lanes be built to move traffic through this intersection quicker.

Third, the intersection at Broadway is a major bottleneck for southbound Route 28 traffic flow. The estimated back of the queue spills back into the tunnel, average speed is reduced to under 3 mph, and 100% of the traffic will stop before clearing the intersection. Refer to Figure 14. Therefore, without addressing traffic problems at Broadway the construction of the new Route 28 southbound tunnel only moves the bottleneck downstream to Broadway.

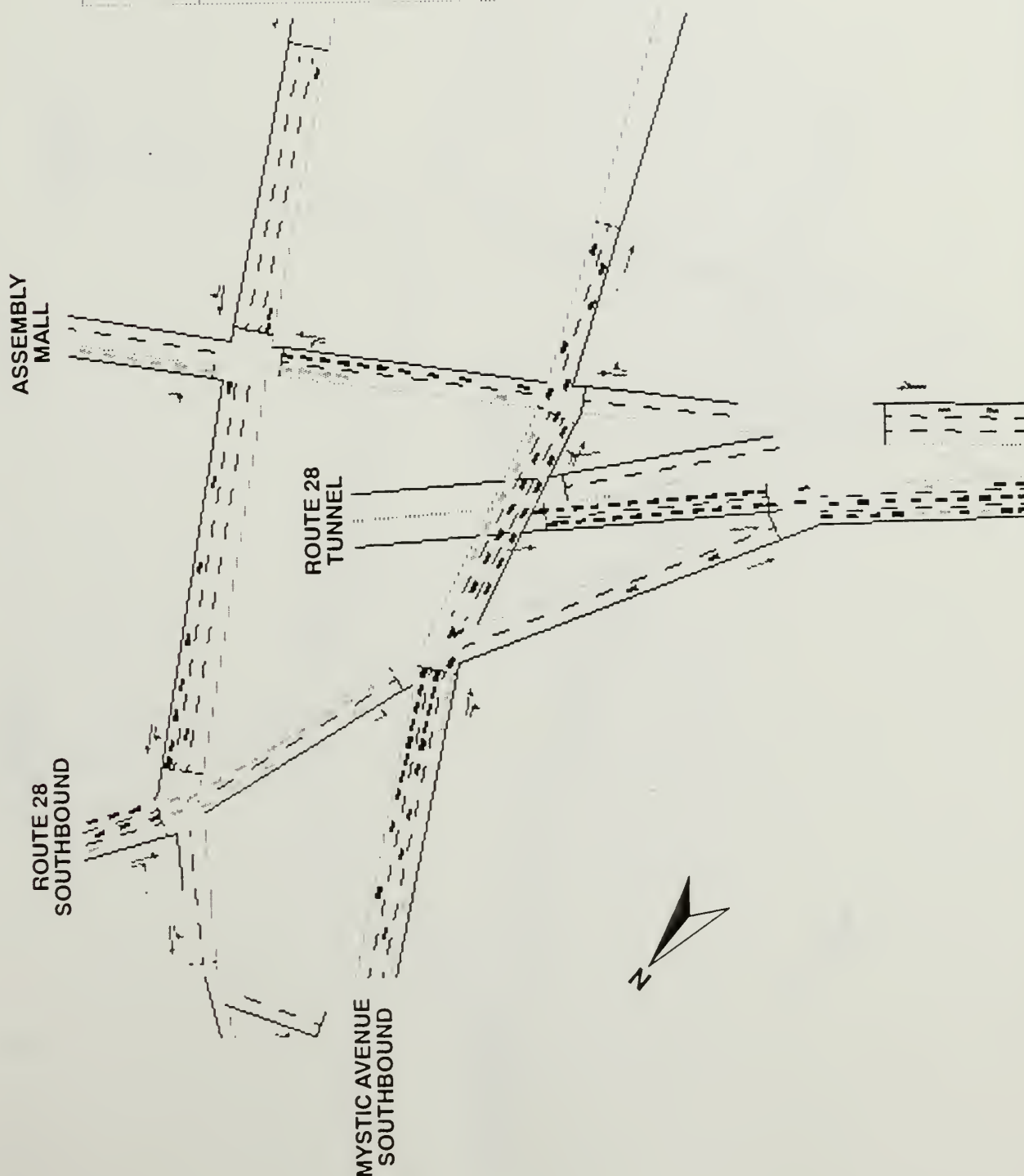
Impact of Preferred Alternative on I-93

The impact of the Preferred Alternative on I-93 was found to be insignificant. This is illustrated by the comparison of screen line volumes between the No Build Alternative and the Preferred Alternative for the build year 2000 and design year 2020. Both scenarios include the Central Artery construction project previously described. Refer to Table 6, AM Volume Comparison, and Table 7, PM Volume Comparison.

Conclusions

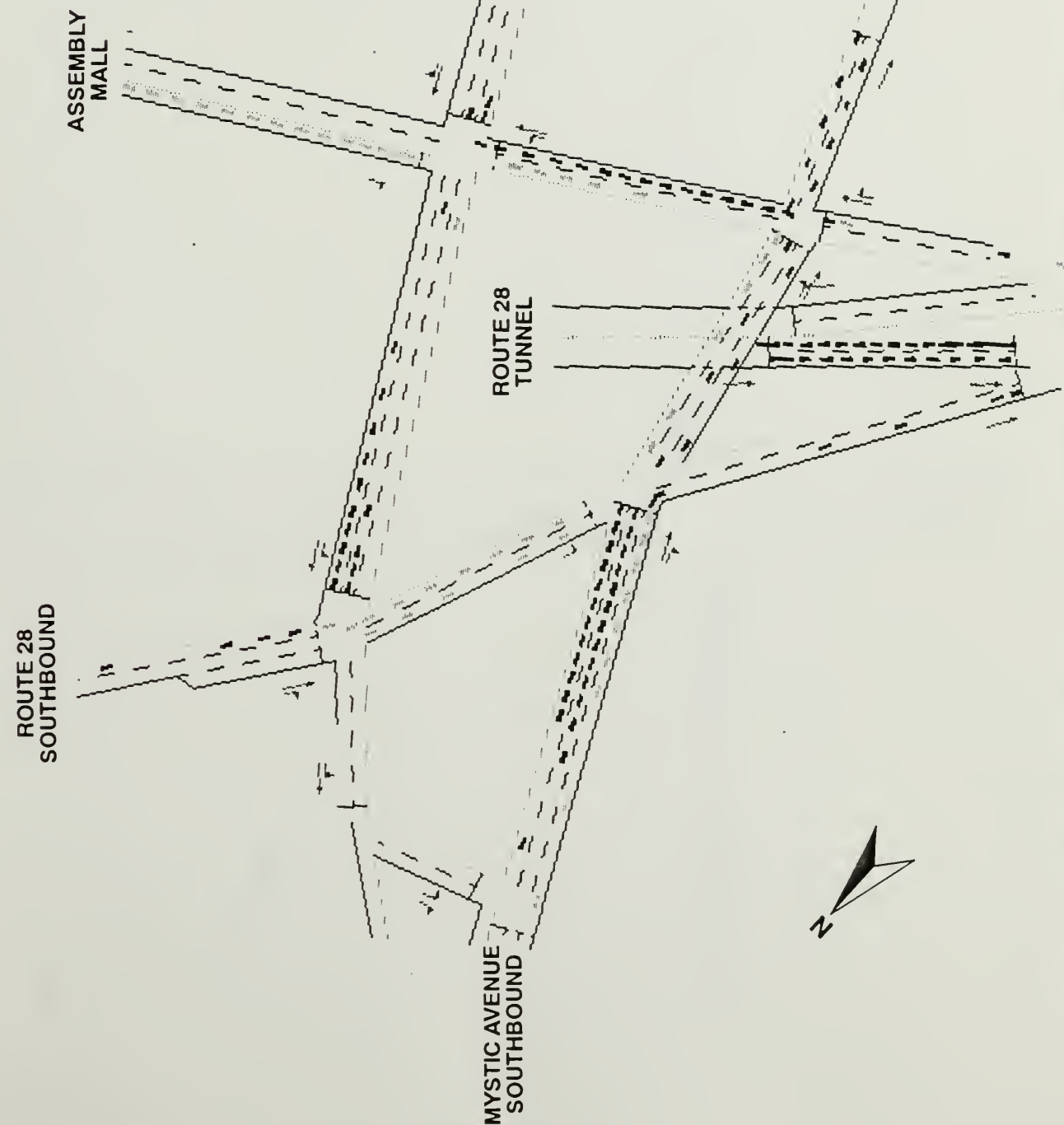
This report supports the selection of the Preferred Alternative design improvements to the Mystic Avenue/Route 28/I-93 interchange. Based on the analysis of build year (2000) and design year (2020) travel demand forecasts for the AM and PM peak hours, it has been demonstrated that the Preferred Alternative will improve the operating level of service during those time periods and have a positive impact on the adjacent roadway system. It has also been demonstrated that it will not adversely impact the mainline I-93 itself, the I-93 interchanges north and south of the project, or the Central Artery construction project.

Figure 12
 Traf-Netsim Simulation
 Route 28/Mystic Avenue, Example A



07:32:14.00 TP 1		
■ Lane Blocked		
Turning movement:	color	legend:
Left	Thru	
Right	Diag	
Left turn signal:		
↑	Unprotected	
↑	Protected	

Figure 13
 Traf-Netsim Simulation
 Route 28/Mystic Avenue, Example B



07:32:33.00 TP 1

■ Lane Blocked

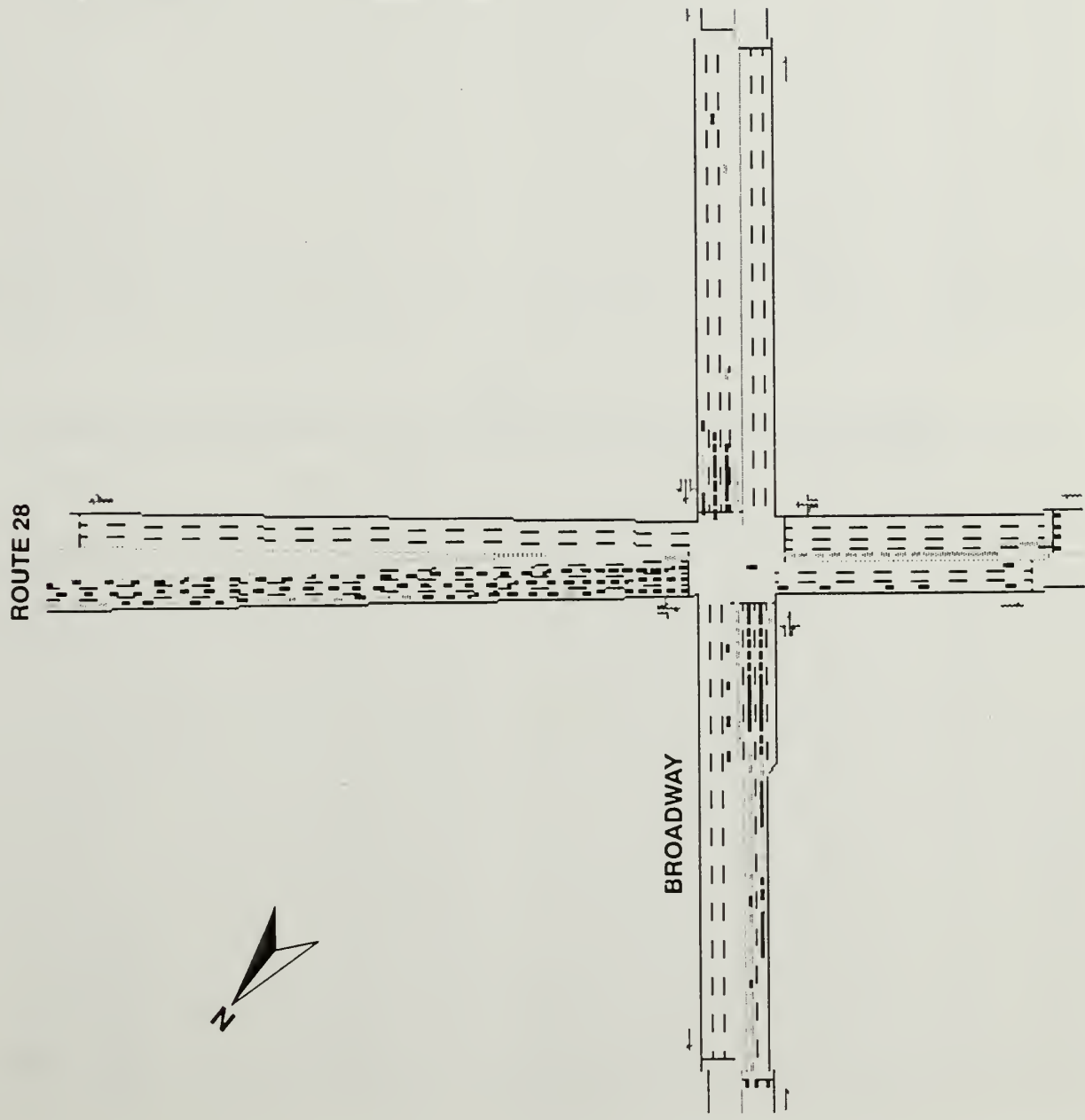
Thru
 Left
 Right
 Left
 Right
 Thru
 Left
 Right

Left turn signal:

Protected

Protected

Figure 14
 Traf-Netsim Simulation
 Route 28/Broadway



07:31:40.00 TP 1	
■	Lane Blocked
Turning movement	
Control	Signal
Left	Thru
Right	Diag
Left turn signal:	
↑	Protected
↑	Protected

Table 6
Year 2000 and 2020 AM Volume with Preferred Alternative

Location	Year 2000 AM				Year 2020 AM			
	NB w/CAT	Pref. w/CAT	Difference	% Change	NB w/CAT	Pref. w/CAT	Difference	% Change
Rt. 28 NB North of Area	1191	1520	329	27.62%	1383	1515	132	9.54%
Rt. 28 SB North of Area	3949	3785	-164	-4.15%	4117	4191	74	1.80%
Rt. 28 NB South of Area	1220	1376	156	12.79%	1465	1423	-12	-2.87%
Rt. 28 SB South of Area	3226	3198	-28	-0.87%	3641	3578	-63	-1.73%
Mystic Ave NB North of Area	819	816	-43	-0.37%	873	807	66	-7.56%
Mystic Ave SB North of Area	1392	1621	229	16.45%	1708	1763	55	3.22%
Mystic Ave NB from Sullivan Sq	1098	1034	-64	-5.83%	1259	1163	-96	-7.63%
Mystic Ave SB to Sullivan Sq	3178	3216	38	1.20%	3432	3365	-67	-1.95%
I-93 NB North of Area	3955	3931	-24	-0.61%	4463	4420	-43	-0.96%
I-93 SB North of Area	7010	6993	-17	-0.24%	7549	7633	84	1.11%
I-93 NB South of Area	4854	4826	-28	-0.58%	5403	5306	-97	-1.80%
I-93 SB South of Area	5321	5372	51	0.96%	5816	5780	-36	-0.62%
Mystic Ave NB On-Ramp	647	671	24	3.71%	722	765	43	5.96%
Mystic Ave SB Off-Ramp	1043	1168	125	11.98%	1259	1258	-1	-0.08%
Sullivan Sq NB On-Ramp	448	436	-12	-2.68%	525	495	-30	-5.71%
Sullivan Sq NB Off-Ramp	1347	1331	-16	-1.19%	1464	1381	-83	-5.67%
Sullivan Sq SB On-Ramp	1039	1182	143	13.76%	1206	1264	58	4.81%
Sullivan Sq SB Off-Ramp	2728	2803	75	2.75%	2939	3116	177	6.02%

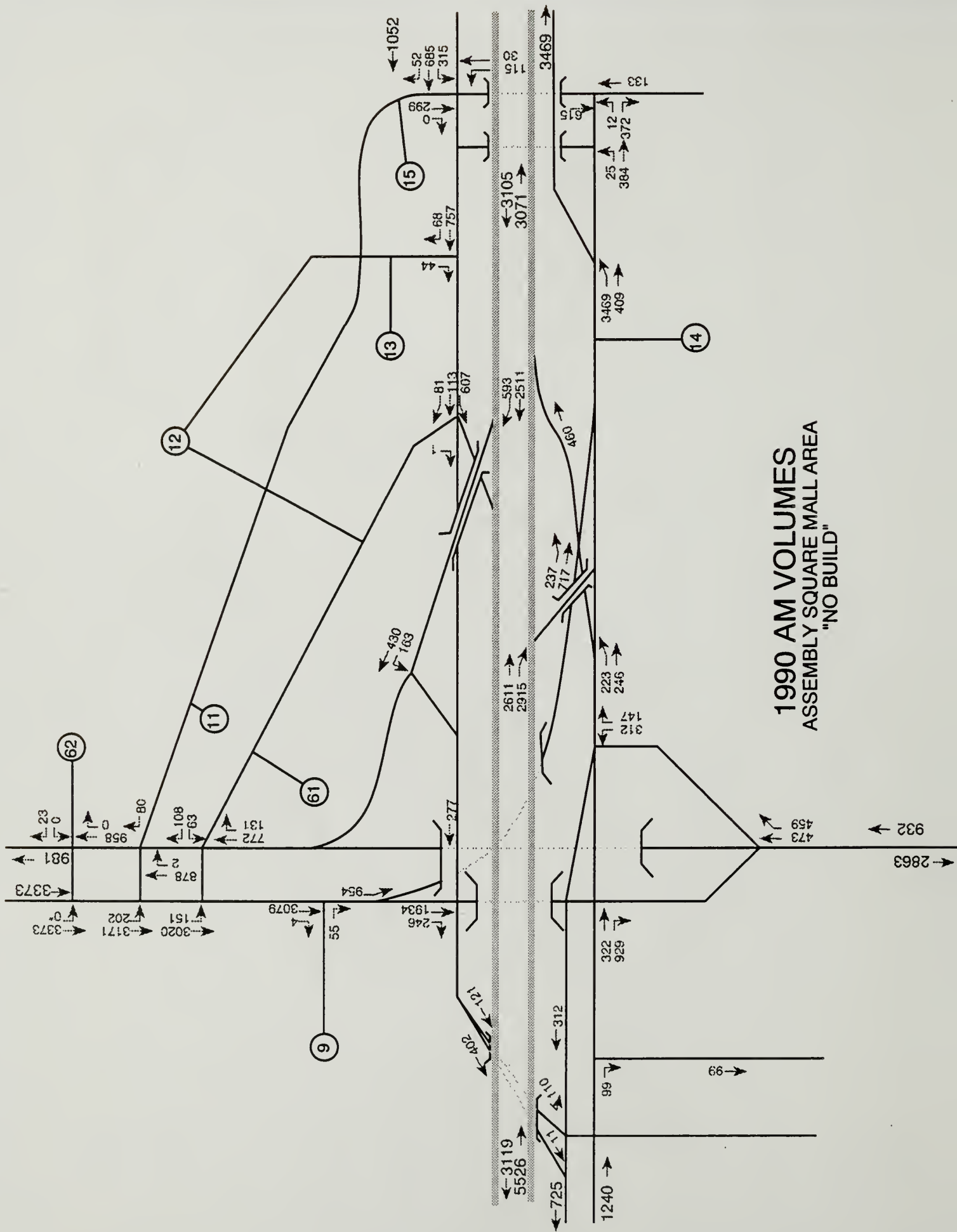
Table 7
Year 2000 and 2020 PM Volume Comparisons with Preferred Alternative

Location	Year 2000 PM				Year 2020 PM			
	NB w/CAT	Pref. w/CAT	Difference	% Change	NB w/CAT	Pref. w/CAT	Difference	% Change
Rt. 28 NB North of Area	2726	2927	201	7.37%	2949	3177	228	7.73%
Rt. 28 SB North of Area	2007	1933	-74	-3.69%	2172	2233	61	2.81%
Rt. 28 NB South of Area	3189	3309	190	3.76%	3539	3364	-175	-4.94%
Rt. 28 SB South of Area	1731	1656	-75	-4.33%	1847	1787	-60	-3.25%
Mystic Ave NB North of Area	1811	1856	143	2.48%	1913	1817	-96	-5.02%
Mystic Ave SB North of Area	1014	1080	66	6.51%	998	1063	65	6.51%
Mystic Ave NB from Sullivan Sq	2512	2270	-242	-9.63%	2817	2678	-139	-4.93%
Mystic Ave SB to Sullivan Sq	1323	1458	135	10.20%	1539	1663	124	8.06%
I-93 NB North of Area	6892	6702	-190	-2.76%	7490	7407	-83	-1.11%
I-93 SB North of Area	4645	4595	-50	-1.08%	5098	5110	12	0.24%
I-93 NB South of Area	5492	5655	163	2.97%	5907	5873	-34	-0.58%
I-93 SB South of Area	4580	4688	108	2.36%	4917	4990	73	1.48%
Mystic Ave NB On-Ramp	2354	2544	190	8.07%	2701	2784	83	3.07%
Mystic Ave SB Off-Ramp	870	968	98	11.26%	952	1001	49	5.15%
Sullivan Sq NB On-Ramp	2396	2008	-388	-16.19%	2618	2652	-1	1.30%
Sullivan Sq NB Off-Ramp	996	961	-35	-3.51%	1035	1118	83	8.02%
Sullivan Sq SB On-Ramp	1282	1384	102	7.96%	1248	1457	209	16.75%
Sullivan Sq SB Off-Ramp	1347	1290	-57	-4.23%	1430	1577	147	10.28%

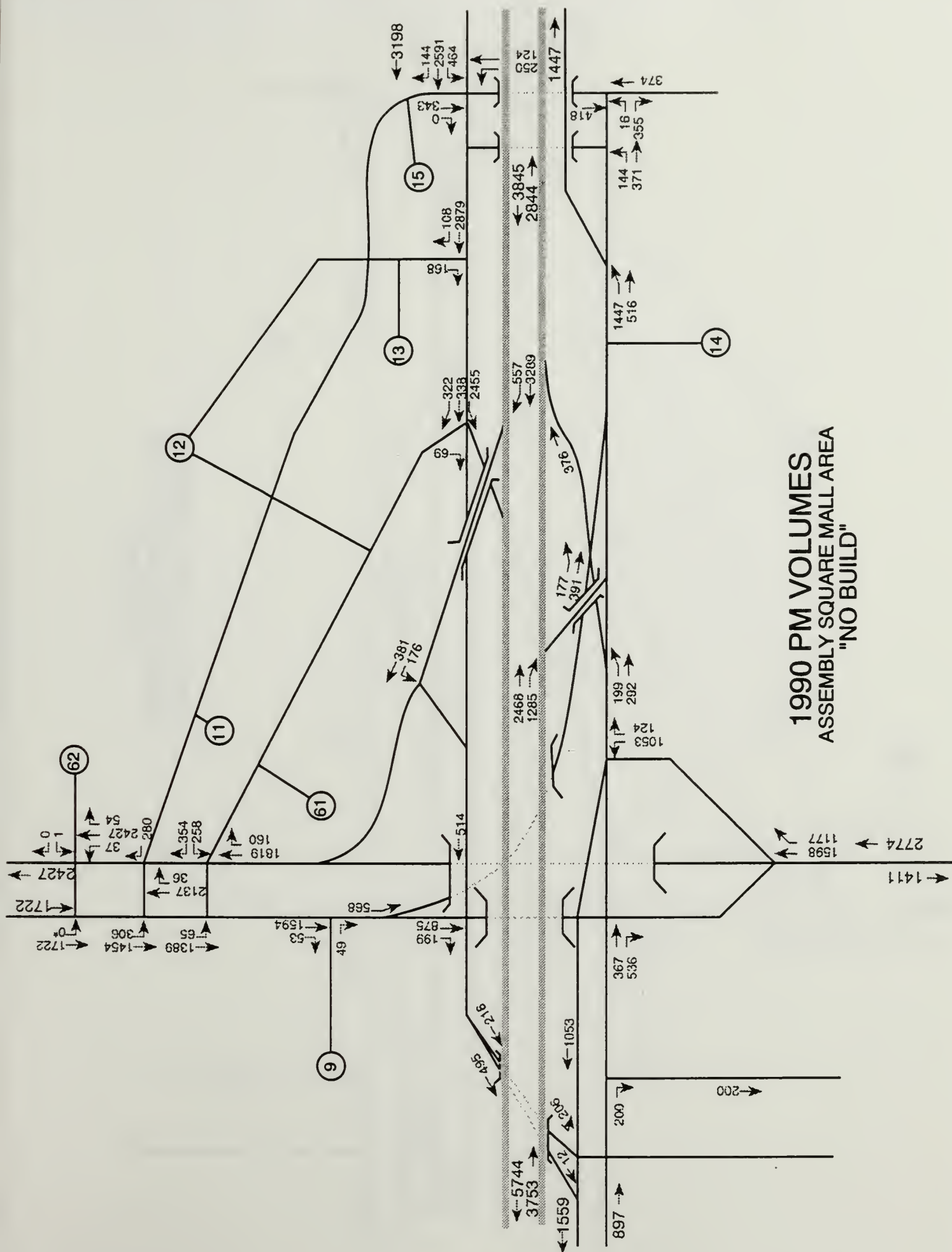
APPENDIX

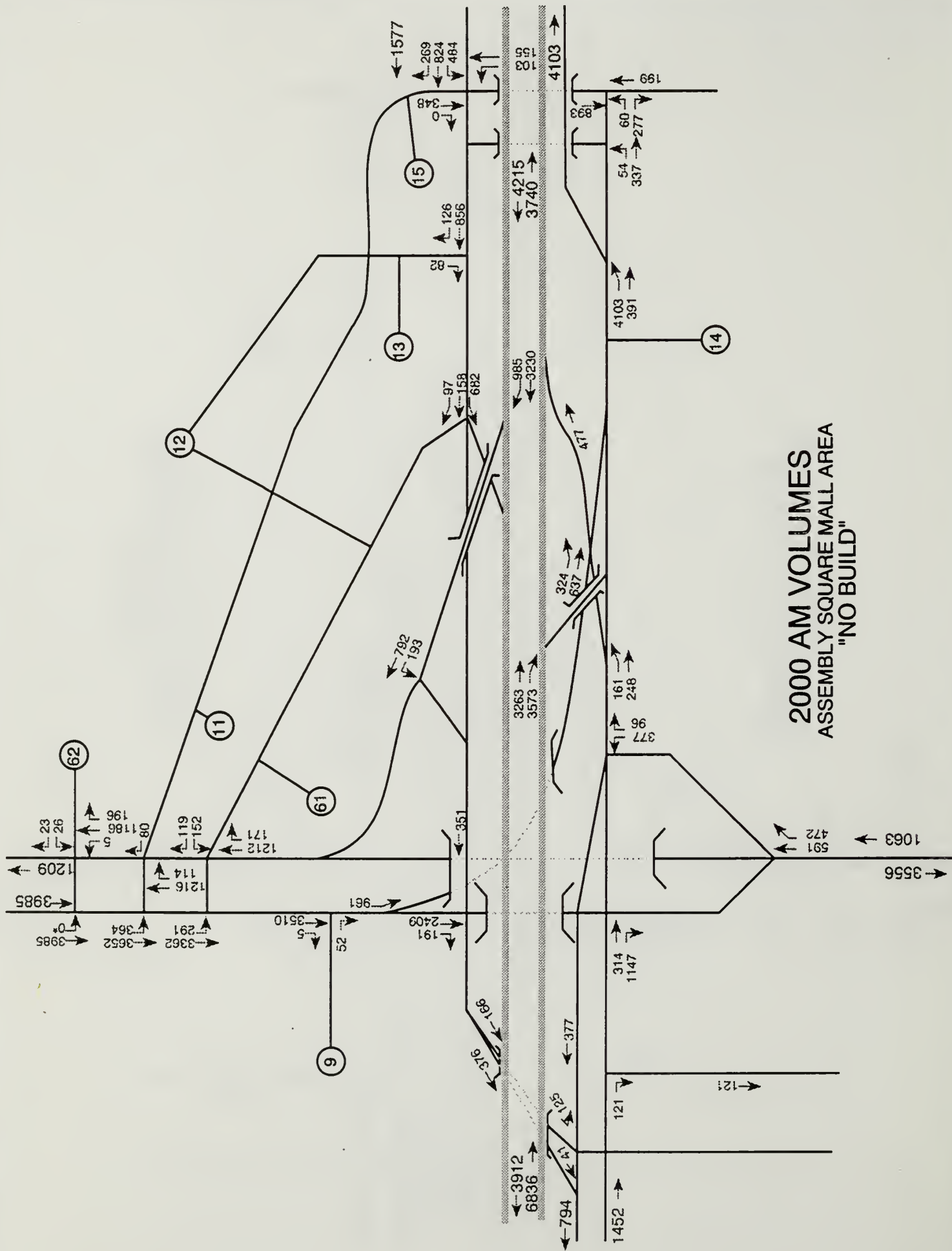
Turning Movement Counts for All Scenarios

Existing Conditions

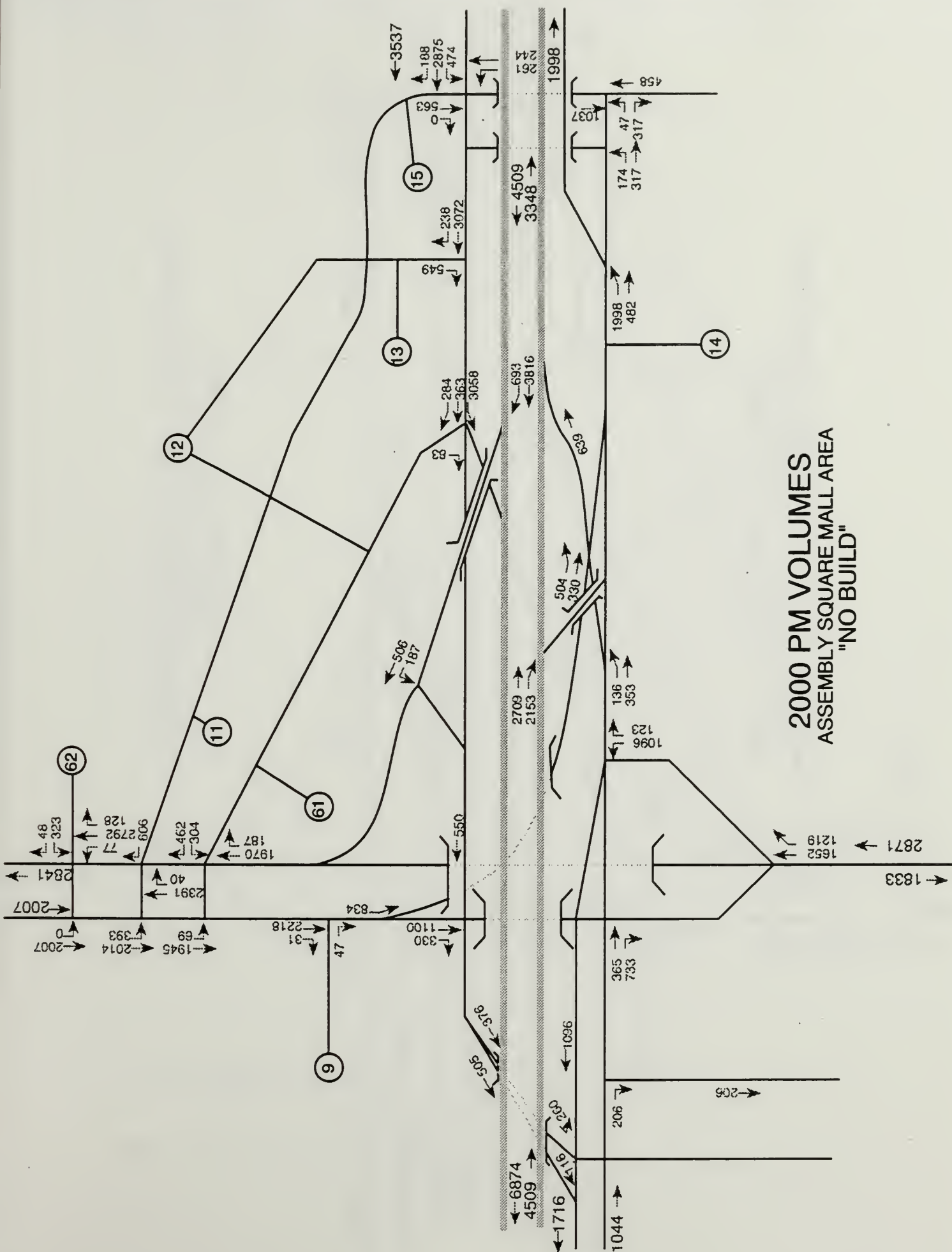


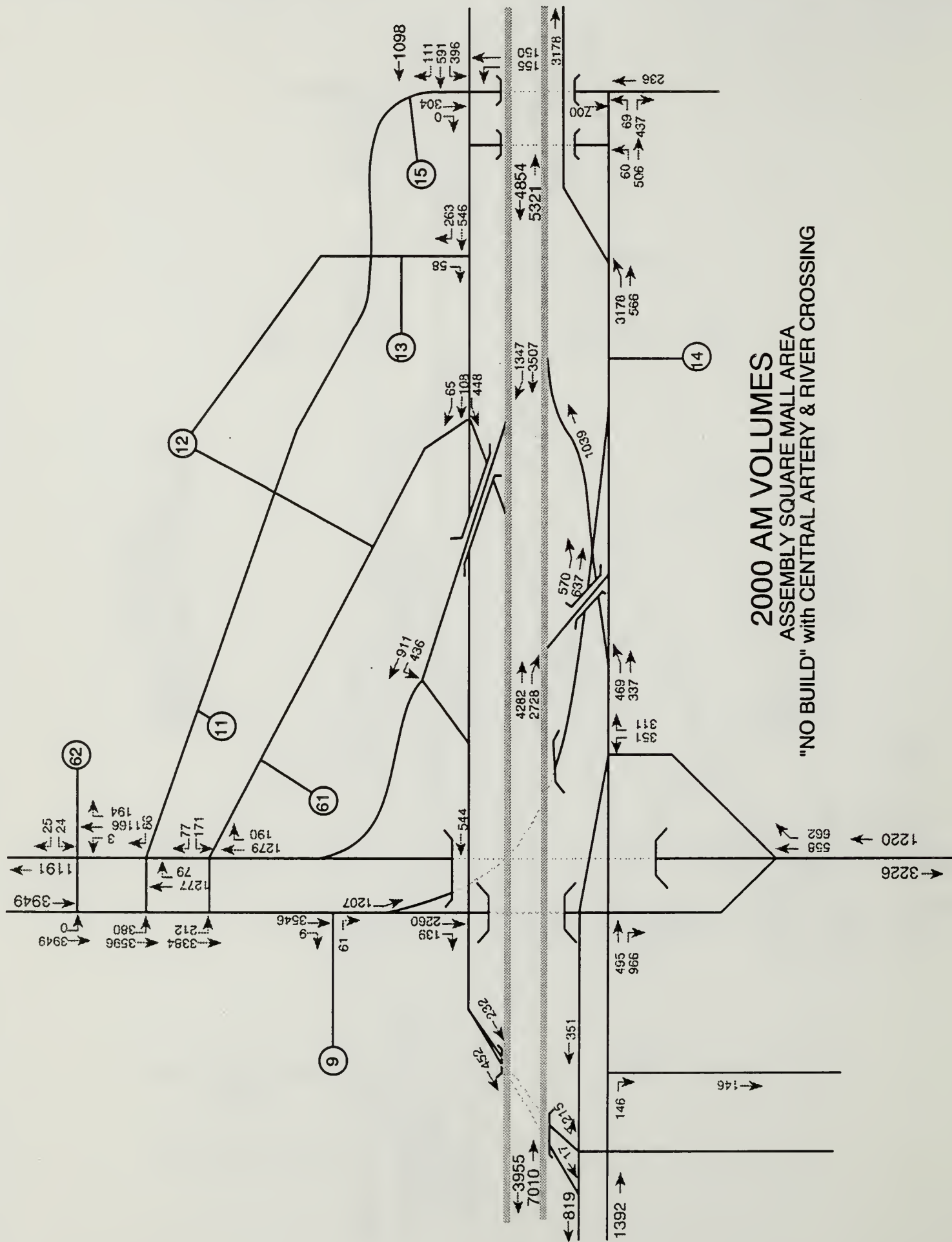
1990 AM VOLUMES
ASSEMBLY SQUARE MALL AREA
"NO BUILD"





2000 AM VOLUMES
ASSEMBLY SQUARE MALL AREA
"NO BUILD"



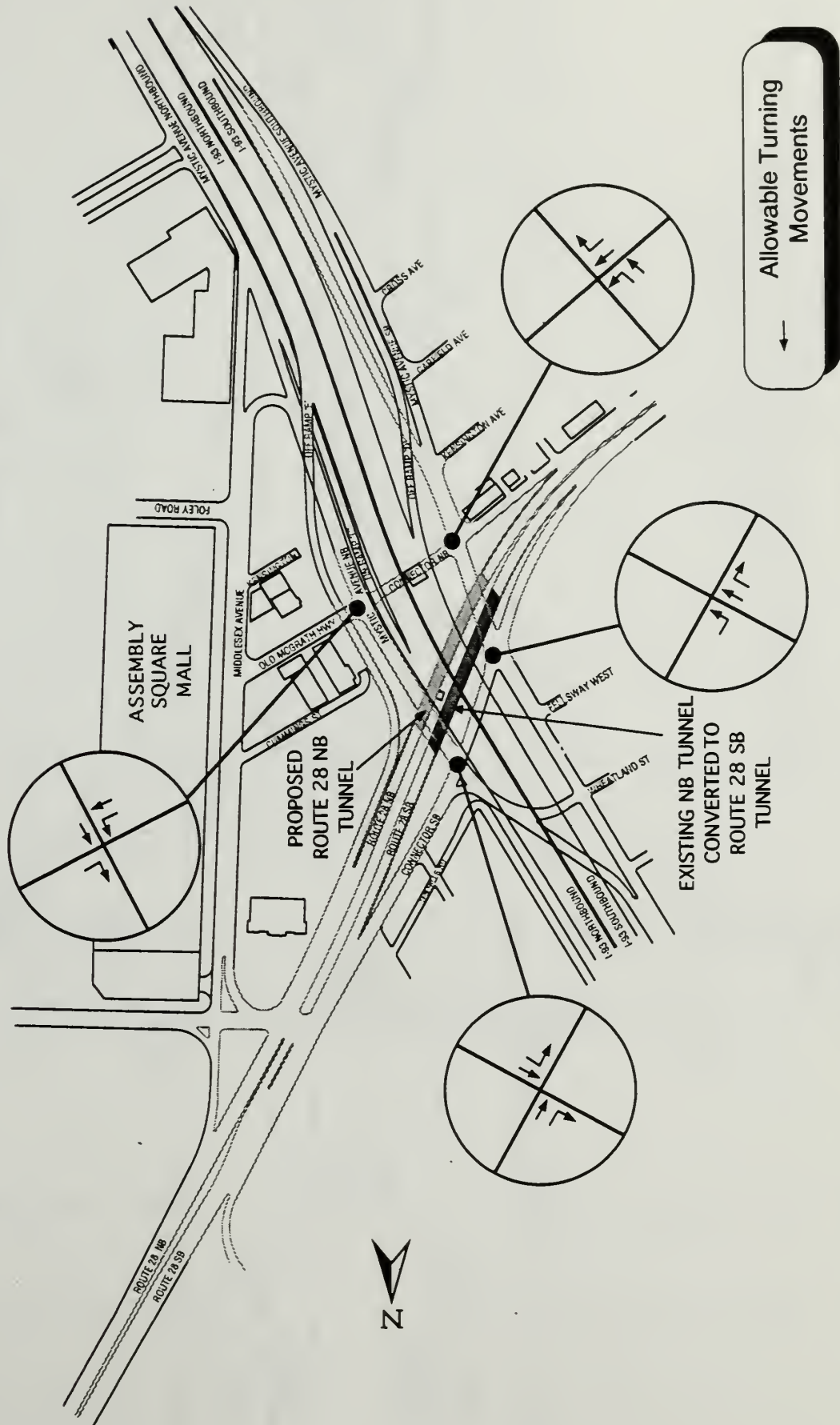


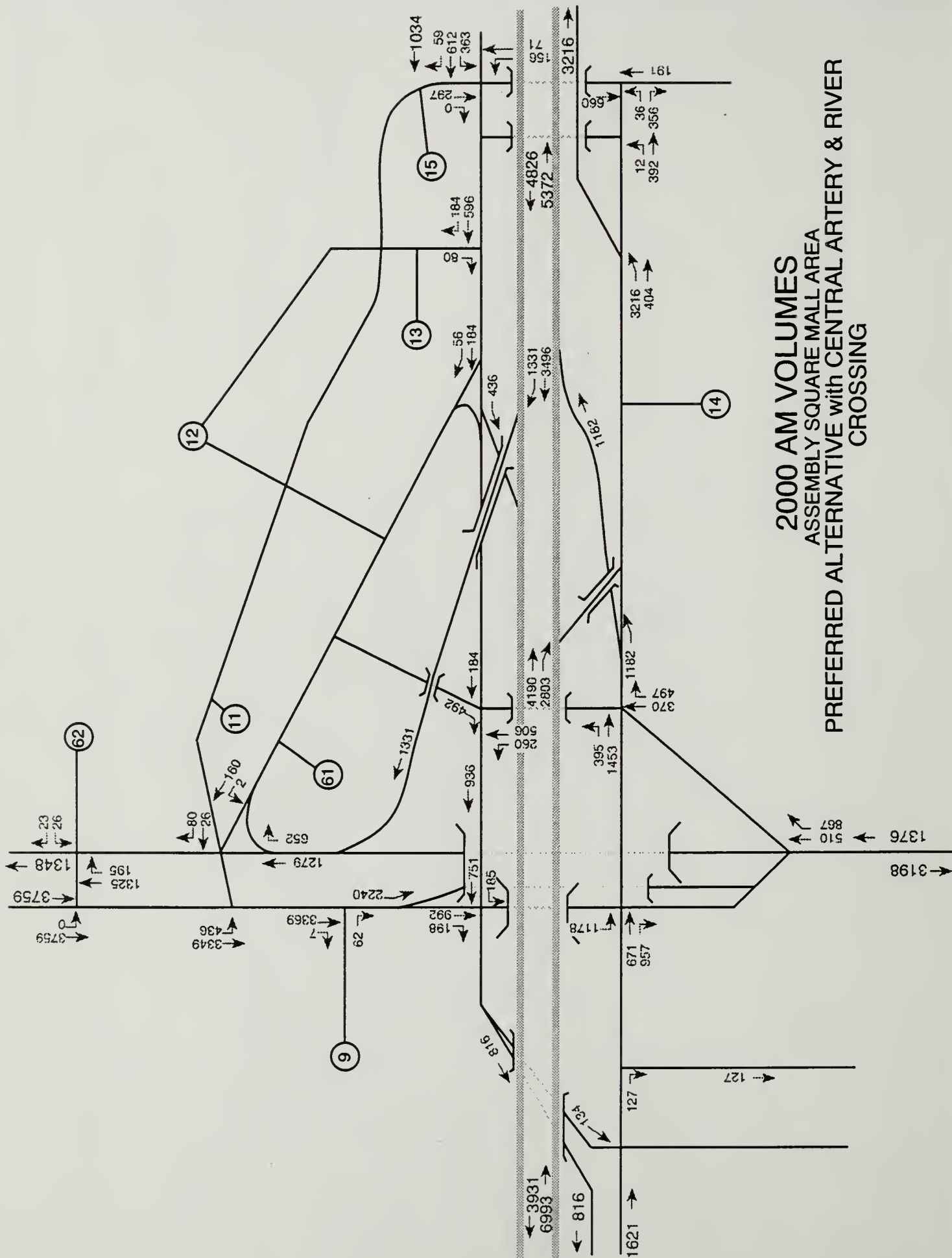
2000 AM VOLUMES
 ASSEMBLY SQUARE MALL AREA
 "NO BUILD" with CENTRAL ARTERY & RIVER CROSSING



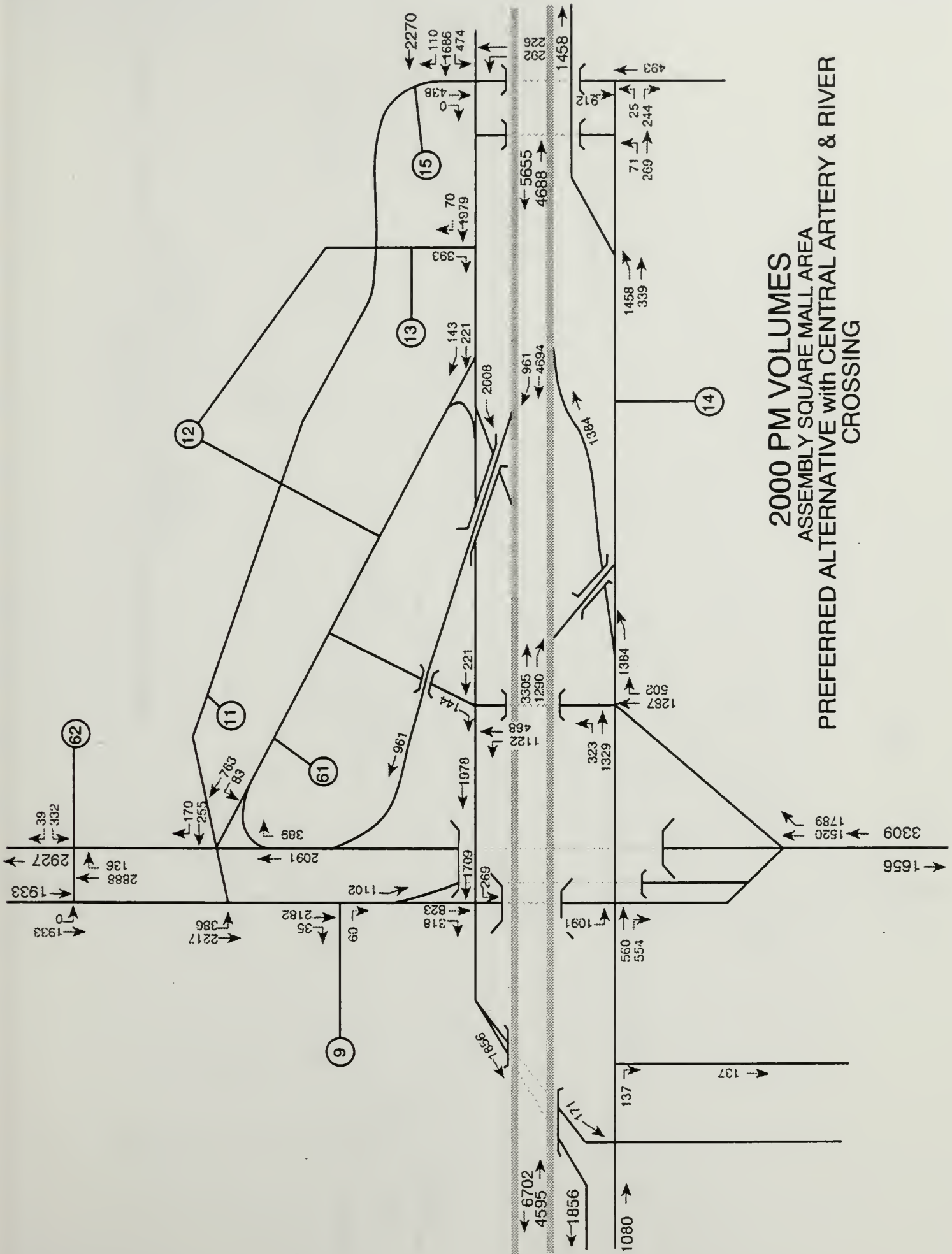
Preferred Alternative

Preferred Alternative



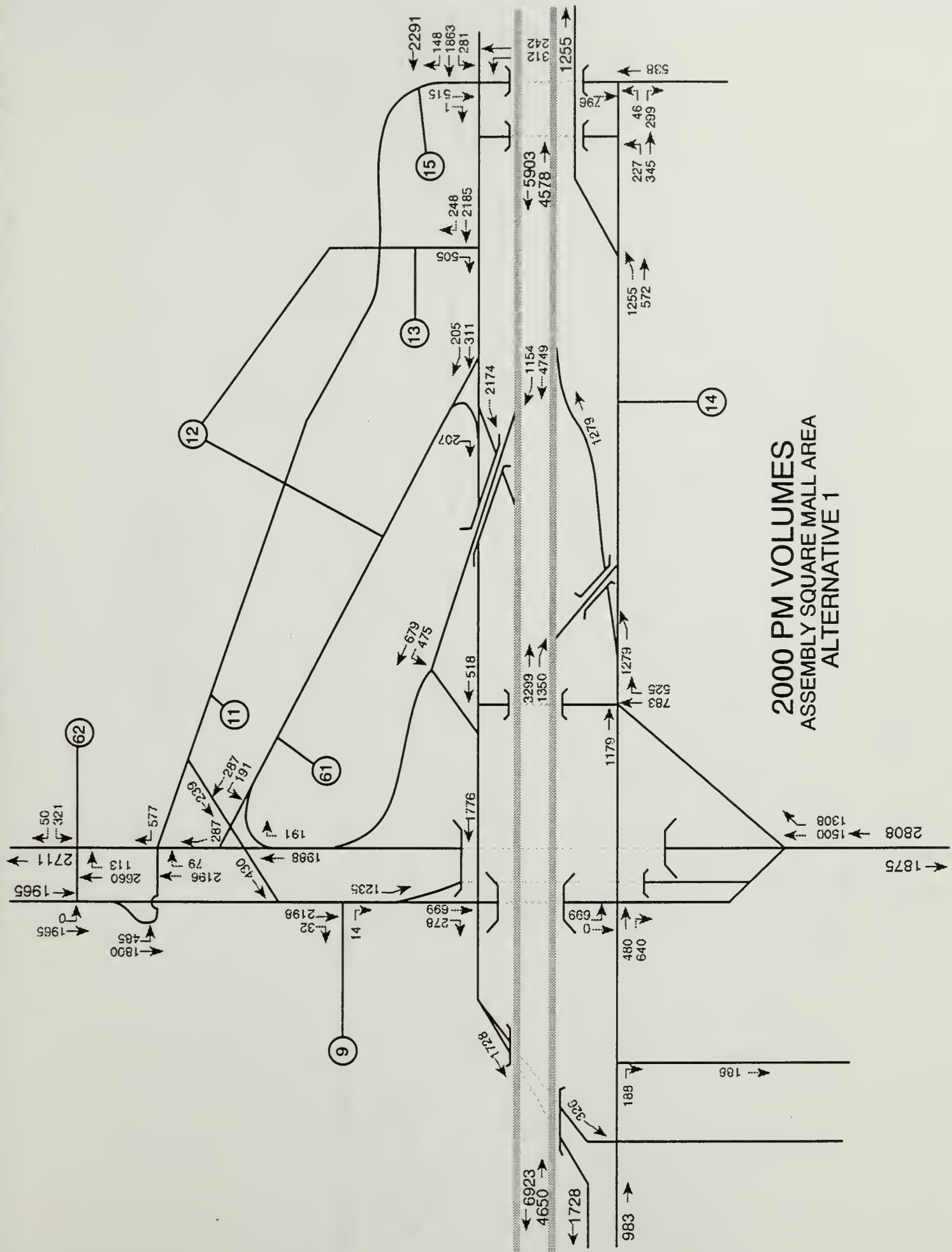


2000 AM VOLUMES
 ASSEMBLY SQUARE MALL AREA
 PREFERRED ALTERNATIVE with CENTRAL ARTERY & RIVER
 CROSSING



2000 PM VOLUMES
 ASSEMBLY SQUARE MALL AREA
 PREFERRED ALTERNATIVE with CENTRAL ARTERY & RIVER
 CROSSING

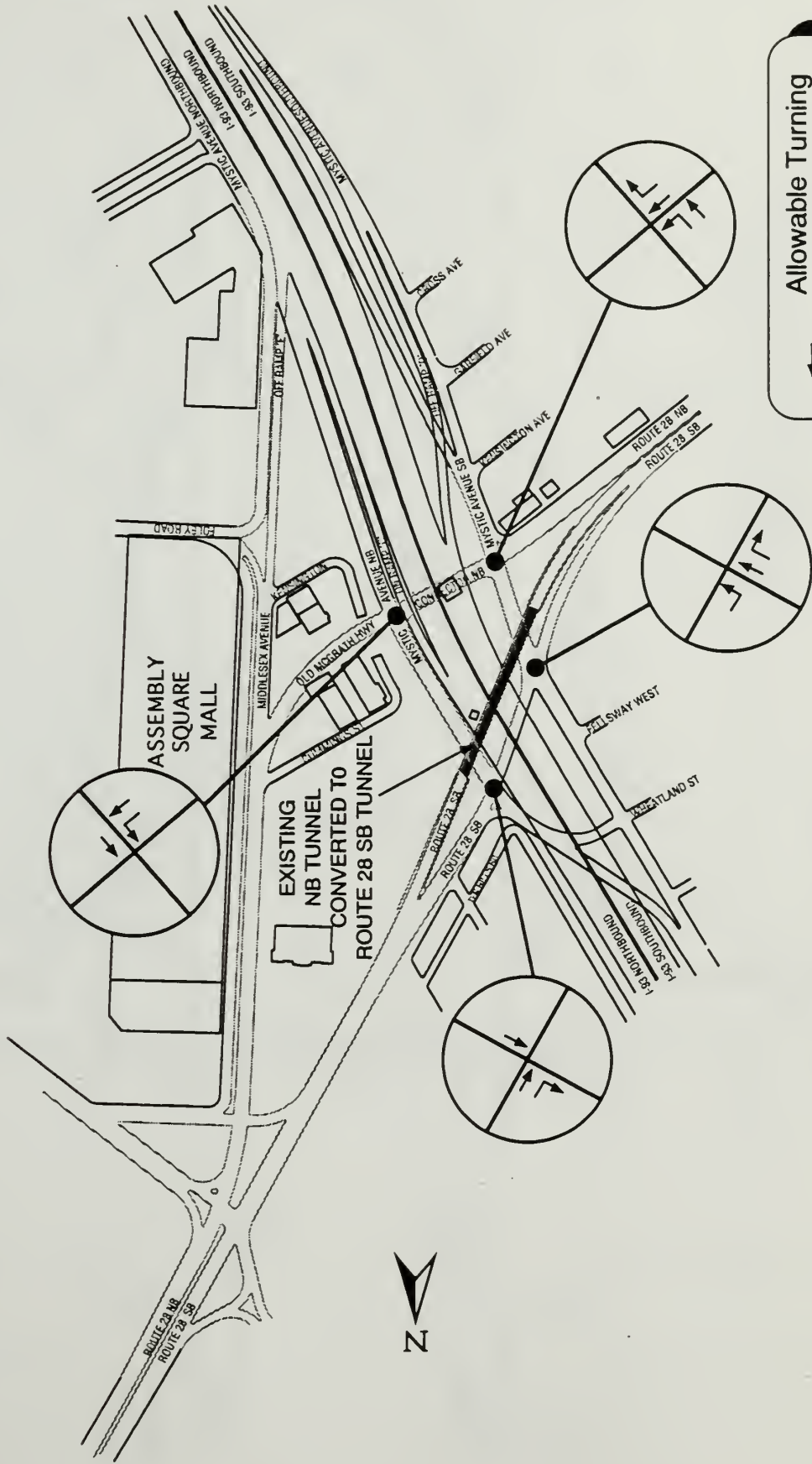
Alternative 1

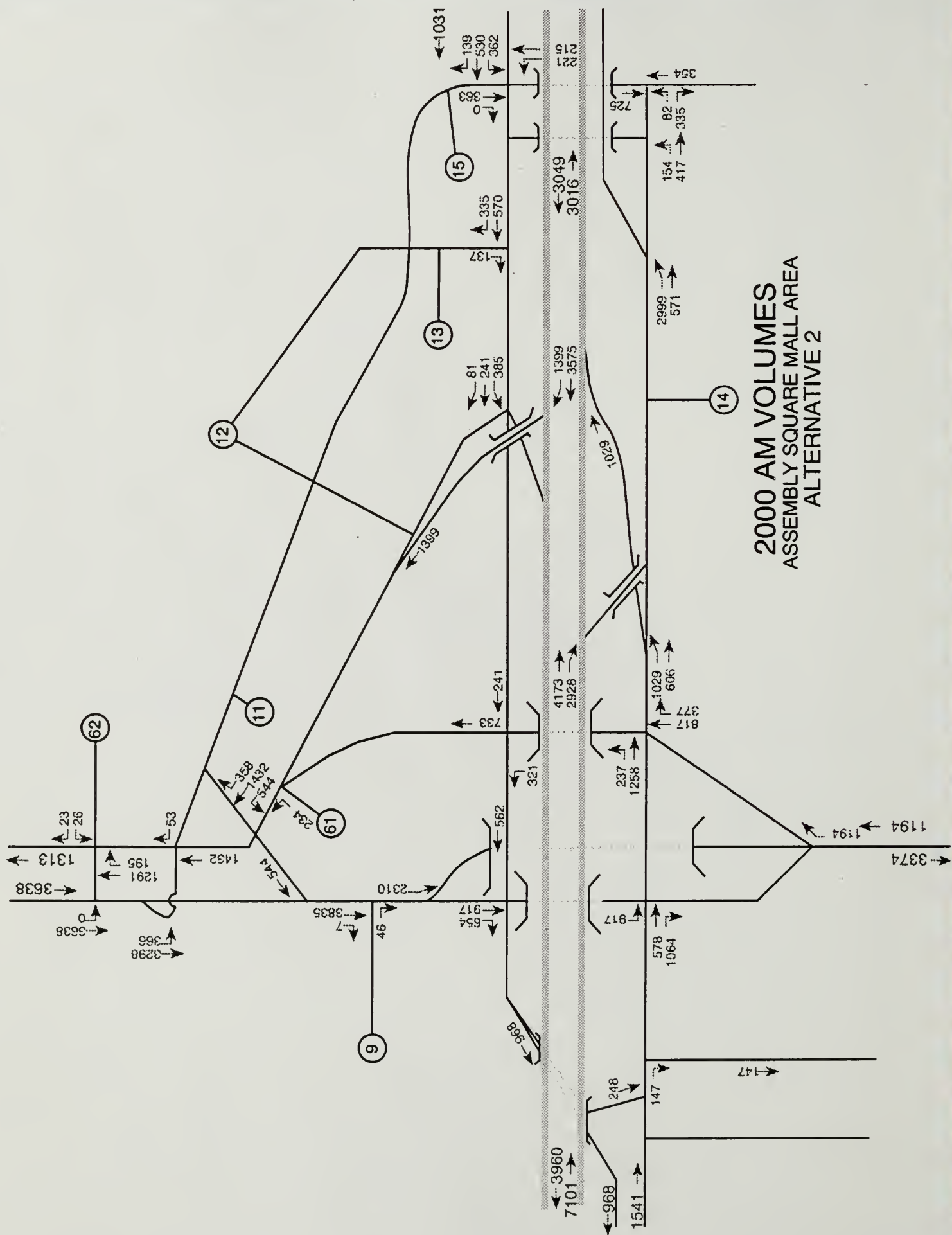


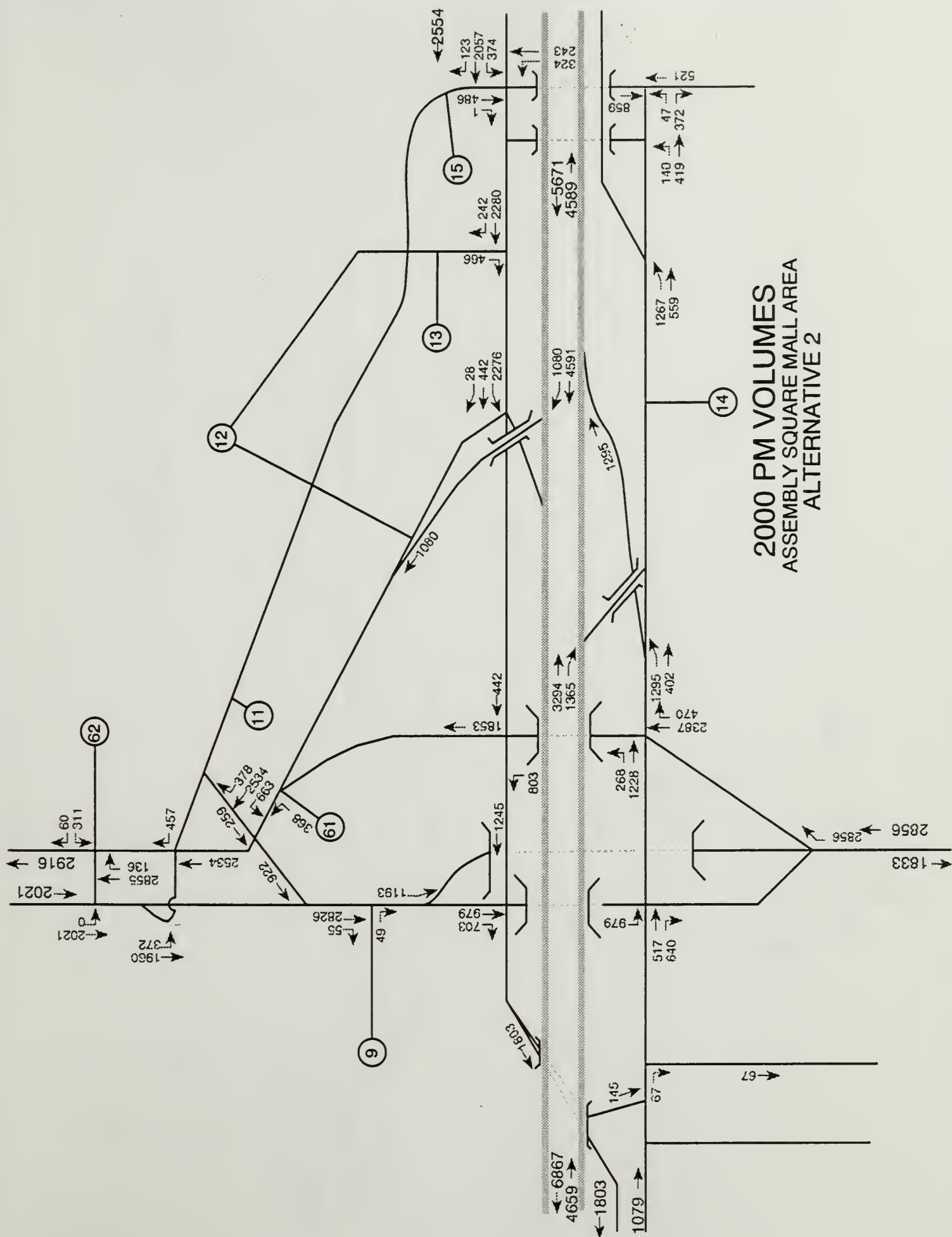
2000 PM VOLUMES
ASSEMBLY SQUARE MALL AREA
ALTERNATIVE 1

Alternative 2

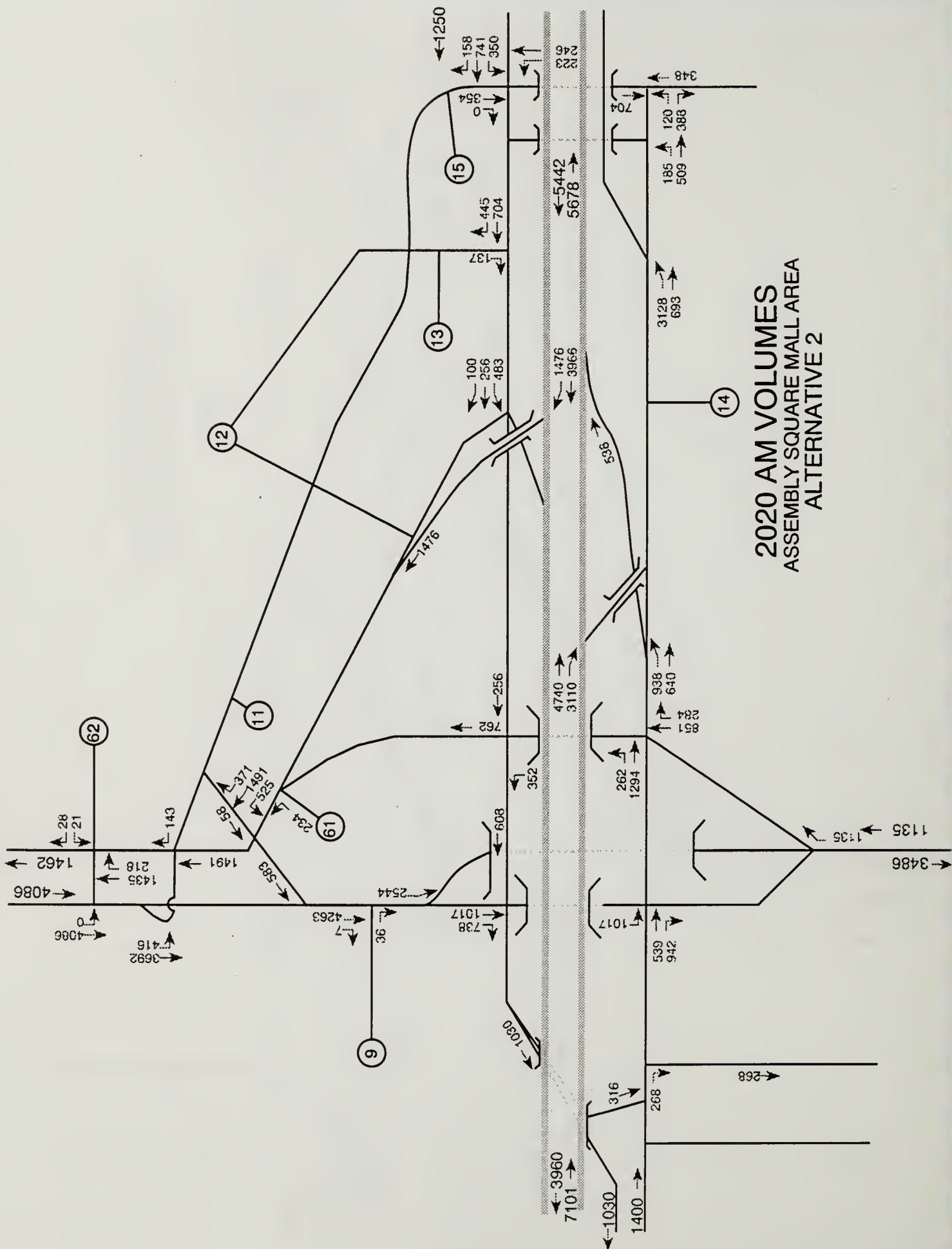
Alternative 2

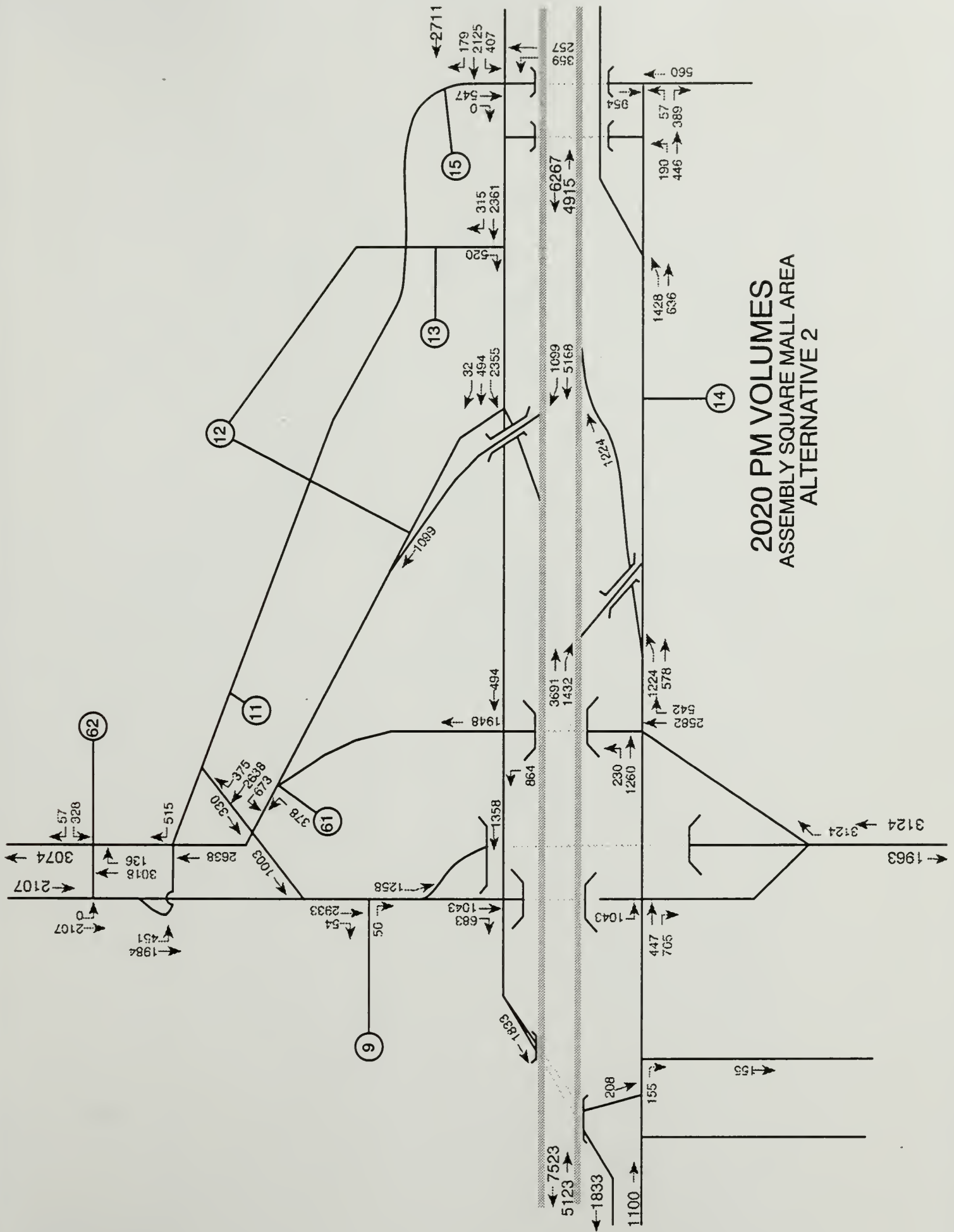






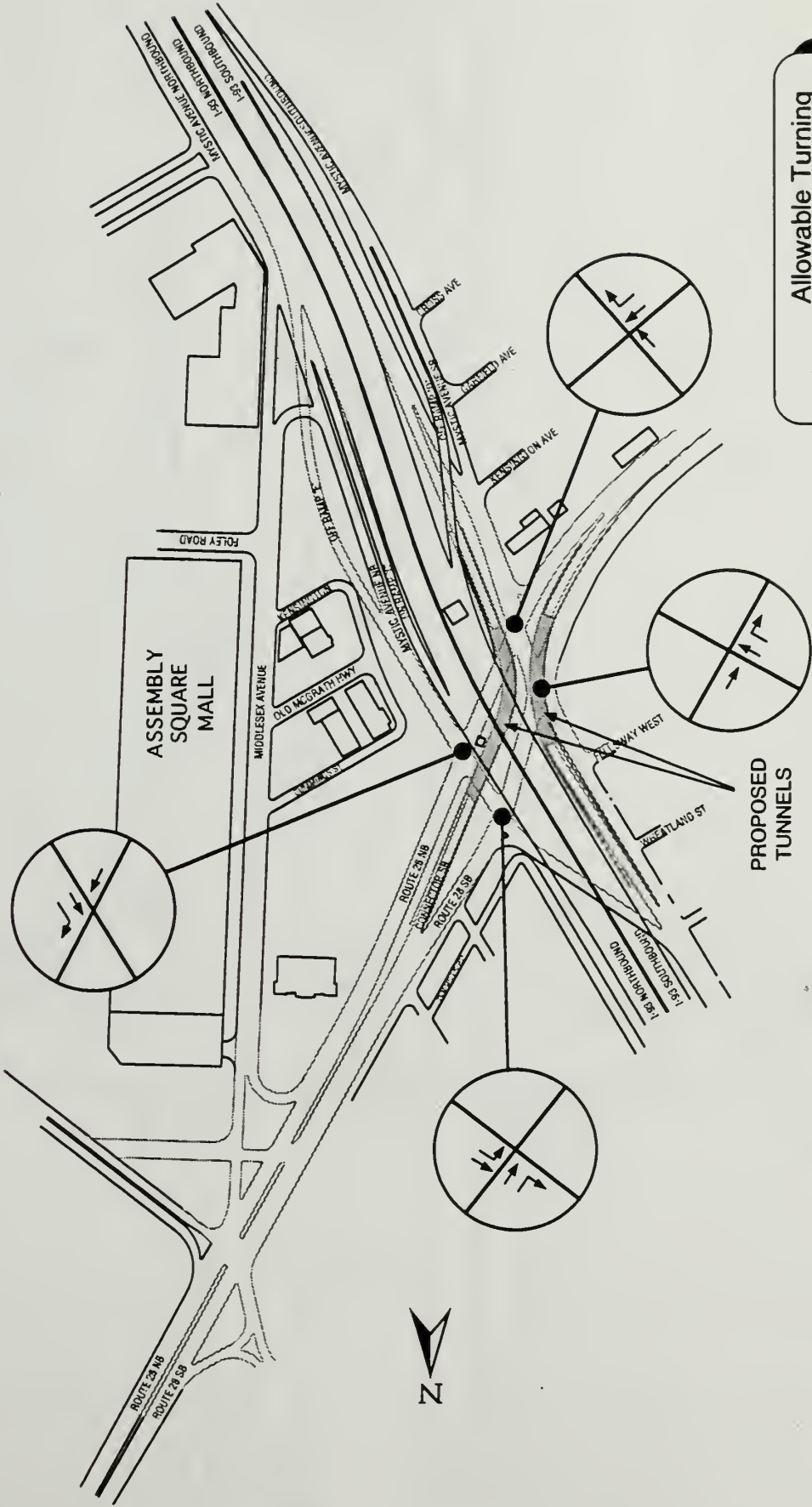
2000 PM VOLUMES
ASSEMBLY SQUARE MALL AREA
ALTERNATIVE 2

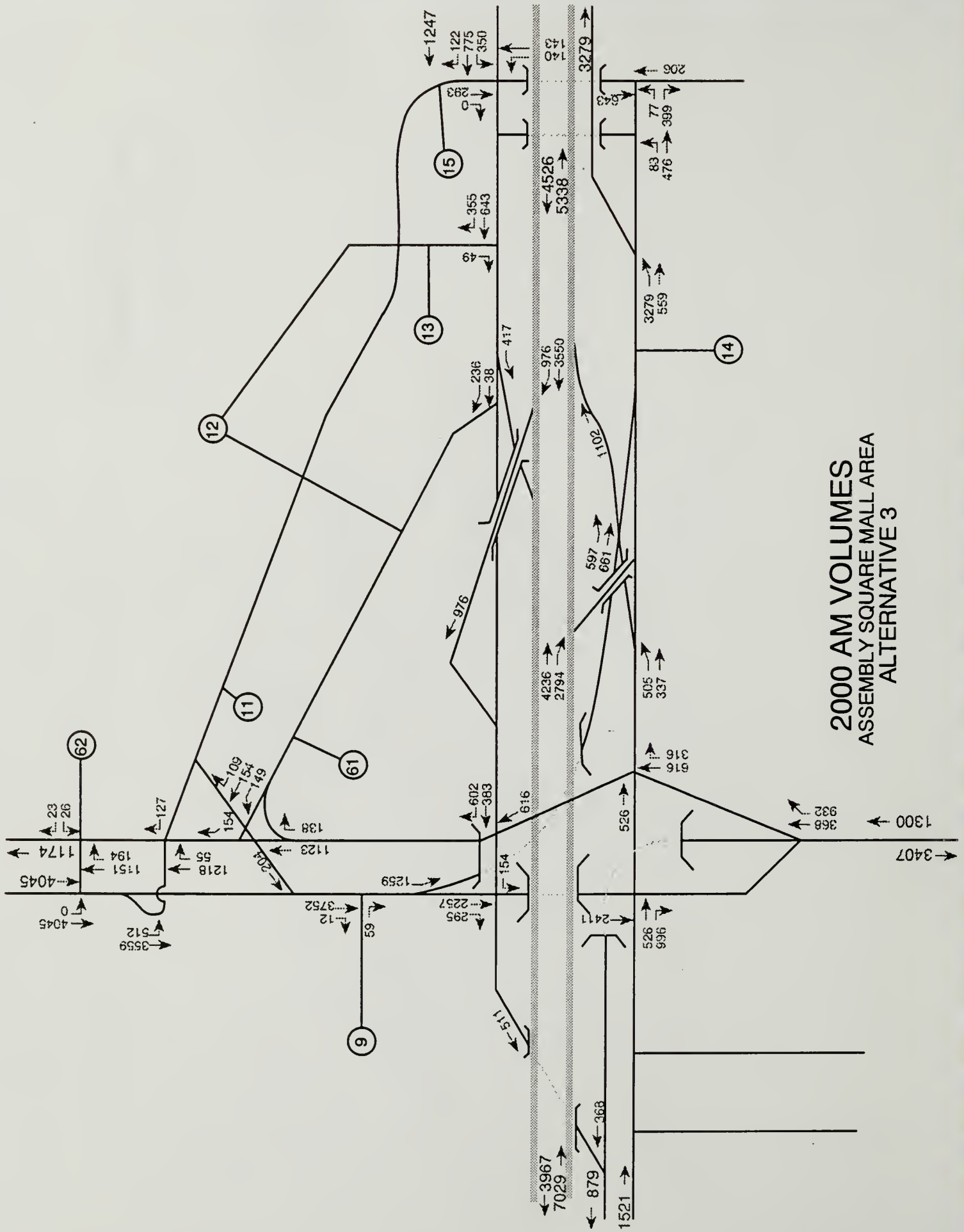




Alternative 3

Alternative 3

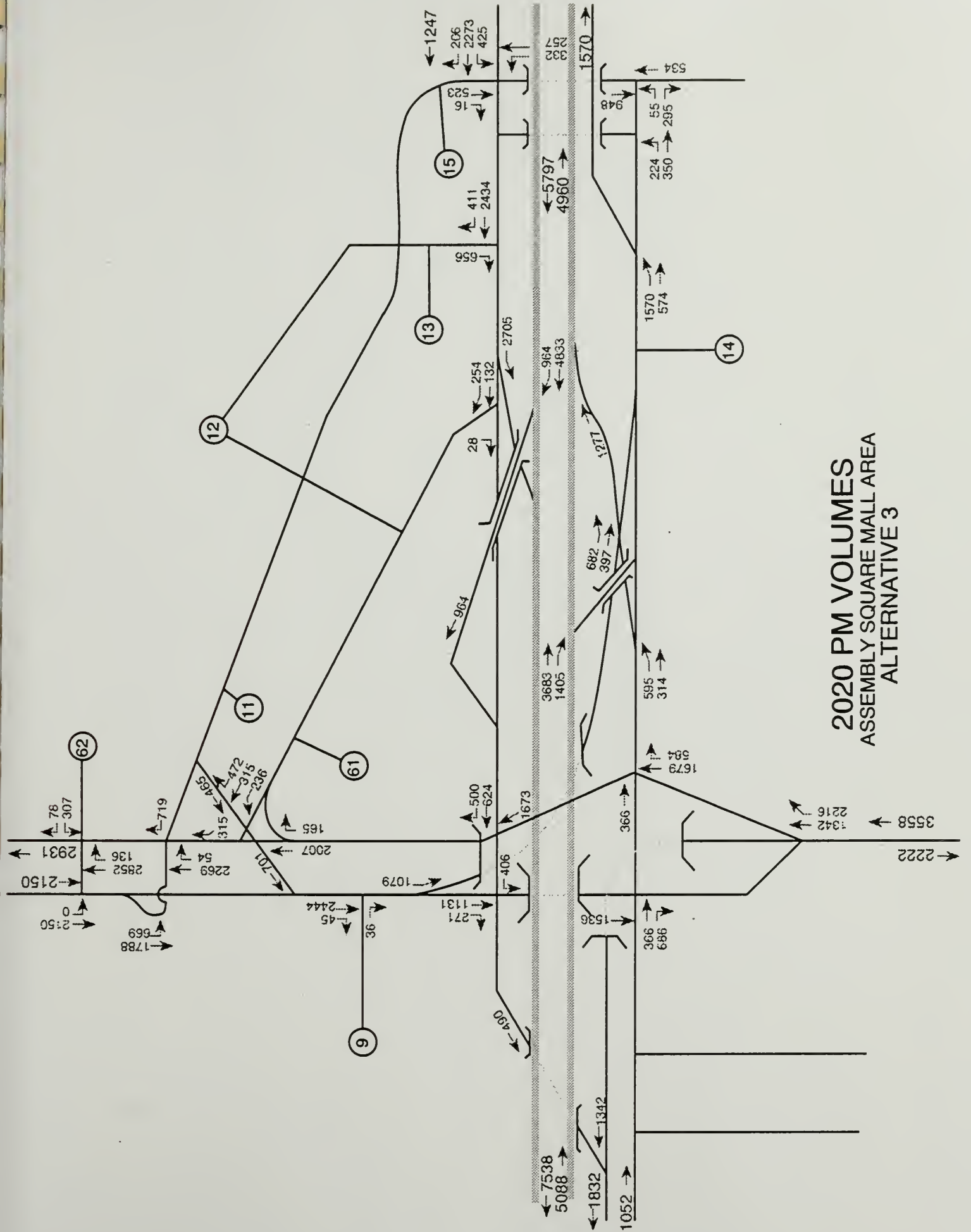




2000 AM VOLUMES
ASSEMBLY SQUARE MALL AREA
ALTERNATIVE 3



2020 PM VOLUMES ASSEMBLY SQUARE MALL AREA ALTERNATIVE 3



Alternative 4

Assembly Square Mall

Middlesex Avenue

Old Derby Road

Middlesex Ave

Derby St

Ashmun Ave

EXISTING NB TUNNEL

ROUTE 28 NB

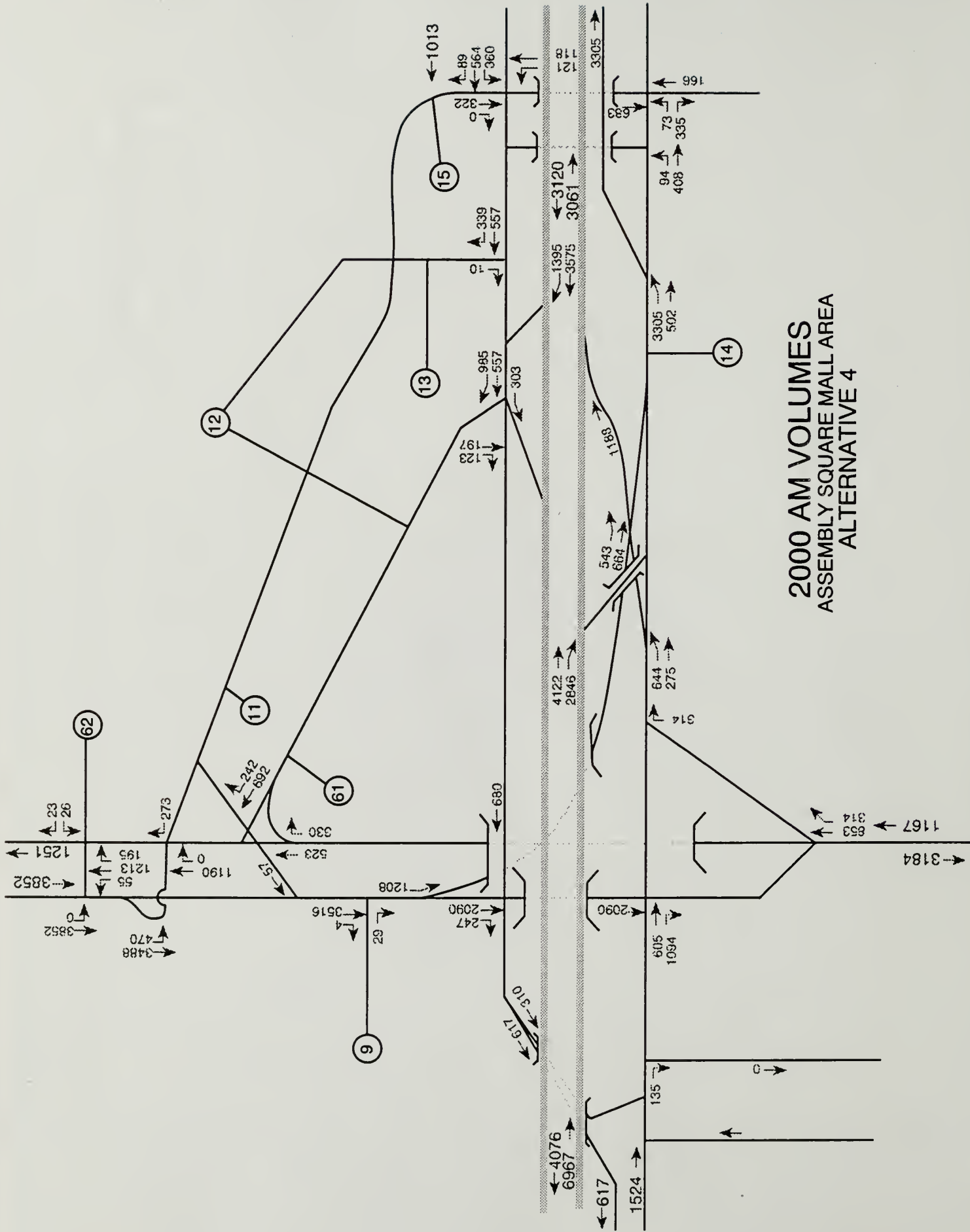
ROUTE 28 SB

Match Line

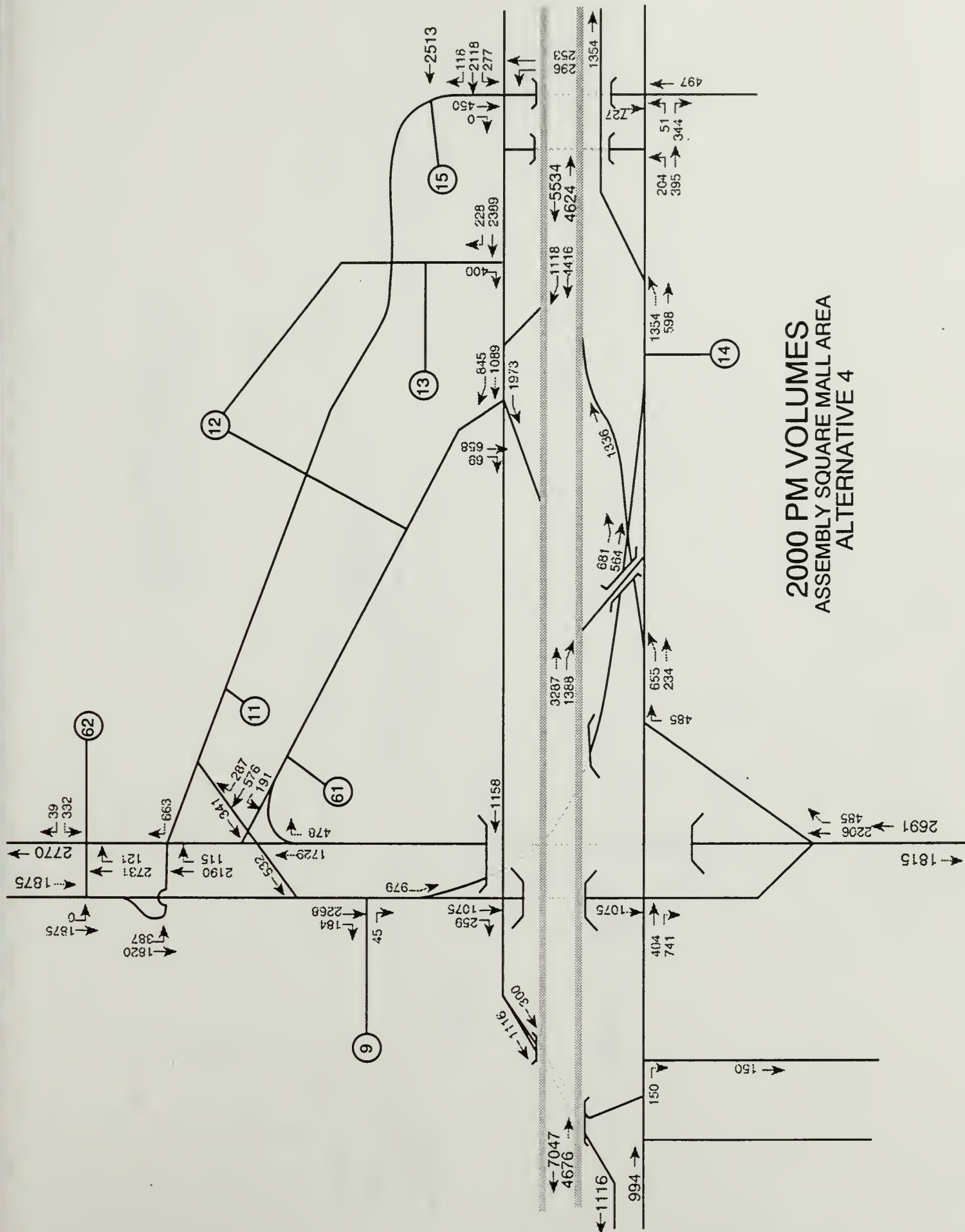
Match Line

Allowable Turning Movements

←
Allowable Turning
Movements



2000 AM VOLUMES
ASSEMBLY SQUARE MALL AREA
ALTERNATIVE 4



2000 PM VOLUMES
 ASSEMBLY SQUARE MALL AREA
 ALTERNATIVE 4

2020 PM VOLUMES ASSEMBLY SQUARE MALL AREA ALTERNATIVE 4

